Australasian Plant Conservation

Bulletin of the Australian Network for Plant Conservation Inc

Volume 29 Number 4 March – May 2021

Featuring articles on plant responses to fire, seed orcharding, translocation and more!

ANPC INC. MISSION STATEMENT: To promote and improve plant conservation

ANPC National Office

GPO Box 1777
Canberra, ACT 2601, Australia

T (02) 6250 9509 | **F** (02) 6250 9599
E anpc@anpc.asn.au
W www.anpc.asn.au

New Zealand Plant Conservation Network

President	Sarah Beadel
Secretary	Rewi Elliot

PO Box 2199, Wellington, New Zealand

E info@nzpcn.org.nz
W www.nzpcn.org.nz

Front cover: Dense seedling recruitment of *Acacia covenyi* with *Brachychiton populneus* resprouting in the background. Photo: Mark Tozer

Printed by: Flash, Canberra.

Australasian Plant Conservation

Editor
Heidi Zimmer

Associate Editors
Nathan Emery and Selga Harrington

Editorial Team
Christine Furnance, Jo Lynch, Lucy Commander, Amelia Yenson, Stephen Bell, Tony Auld, Meredith Cosgrove and Tom Le Breton.

Layout & Graphic Design
Siobhan Duffy

Australasian Plant Conservation is produced by the ANPC Inc. with assistance from the Australian National Botanic Gardens.

Australasian Plant Conservation is printed on recycled paper.

ISSN 1039–6500

Contributing to *Australasian Plant Conservation*

Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research and diary dates are welcome. General articles on any plant conservation issue are most welcome.

The deadline for the autumn 2021 issue is 1 May 2021. If you are intending to submit an article or wish to discuss possibilities, please email the editor, Heidi Zimmer: **editor@anpc.asn.au**.

Authors are encouraged to submit images with articles or information. Please submit images in electronic format, resolution needs to be at least 300 dpi, at least the size that they are to be published, in tif, jpg or gif format. Guidelines for authors and an article template are at: **http://www.anpc.asn.au/apc**.

Using the article template, please send articles, no more than 1200 words, as an MS Word file by email to: **editor@anpc.asn.au**.

This issue

Regular features

From the editor

HEIDI ZIMMER

Welcome to the autumn issue of Australasian Plant Conservation (APC). In this issue we continue to learn about the impacts of the fires from more than a year ago. We begin with the annual report from the president of the Australian Network for Plant Conservation (ANPC), Dr. Tony Auld, detailing the many achievements of the ANPC in 2020, and looking forward to some important projects in 2021.

Continuing with APC's ongoing coverage of plant responses to fire, Glenn Hayward and Alison Shapcott describe the fire response of the endangered rainforest tree *Macadamia jansenii* which, encouragingly, appears to have the ability to resprout basally. Next, remaining on impacts of the 2019–2020 fires, Mark Tozer and others investigate post-fire regeneration in the Bendethra Shrublands, in southeast NSW. Among their observations, they record dense regeneration of *Acacia covenyi* and declines in *Beyeria lasiocarpa* and *Myoporum acuminatum*.

Shifting focus next to restoration, for three decades, Marrinup Nursery in Western Australia produced seed for restoration of Jarrah forest. Here, David Willyams tells the story, and shares the learnings, from this very special project. Next, to Queensland, where Alison Shapcott *et al.* describe the translocation of *Pomaderris clivicola*, and highlight the potential benefits of clonal propagation.

Our regular features begin with News from the Australian Seed Bank Partnership, Damian Wrigley talks about Project Phoenix, seeds and conservation action in the wake of the 2019-2020 bushfires. We then have a short update on the Healthy Seeds Project, followed by our ANPC member profile. This issue we talk with Luke Sweedman, recently retired Curator of the Western Australian Seed Centre. We end the issue with some great book reviews, ANPC news and conferences and research roundup. Enjoy!

President's report

To the Annual General meeting, 11 November 2020

TONY AULD

ANPC President, Australian Network for Plant Conservation Inc. Email: anpc@anpc.asn.au

I am very proud to say that 2020, our 29th year, has been a highly successful year for the ANPC and our role as Australia's non-government key plant conservation organisation.

The conservation of Australia's plants, animals and natural habitats was on everyone's minds after the 2019/20 bushfires that burnt an unprecedented area of eastern Australia. That was shortly followed by COVID-19 restricting movement and face to face communication.

The 2019/20 bushfires have sadly had a huge impact on our unique plants and ecological communities. Much of the Australian flora has evolved to cope with fire, recovering by re-sprouting or seed germination. However, some plants are sensitive to fire, while others are affected when fires are too frequent or severe, or where fire is combined with drought stress or other threats to post-fire recovery (such as feral animals, weeds and pathogens). Successful recovery after the fires may be a long process and requires effective management of on ground threats, while some species may need further intervention where populations have been lost or are in marked decline due to the impacts of these fires. We are only just beginning this recovery journey.

In 2020, COVID-19 has unfortunately severely impacted our ability to hold face-to-face workshops and conferences which are one of our raisons d'être. At the same time, it has also made us all more adept at on-line meetings and workshops and in 2021 we are planning some virtual and small-scale local events. The ANPC has also fortunately received significant project and grant funding this year to keep us extremely active in the plant conservation sphere, as well as financially viable, and the pandemic has fortunately had little effect on our staffing hours and abilities to undertake these projects, as most staff work remotely so can continue with their work in a safe manner.

Projects

This year we have been very busy implementing the Healthy Seeds project, led by Project Manager Martin Driver, and funded by the NSW Environmental Trust, which commenced in September 2019 and is running for 18 months. This project aims to deliver an evidence-based Roadmap to secure a reliable, genetically appropriate, native seed supply in NSW for restoration. A consortium of partners from across the native seed and ecological restoration sectors is overseeing the project including Greening Australia, CSIRO, NSW Royal Botanic Gardens and Domain Trust, NSW Department of Planning, Industry and Environment, the Australian Association of Bush Regenerators, the Australian Seed Bank Partnership, and the Society for Ecological Restoration Australasia, and we thank them for their time and efforts. The project has also forged close links with the federally funded bushfire recovery Project Phoenix where there are overlaps in objectives and outputs. A Draft Healthy Seeds Summary Roadmap is currently in preparation and an early Draft Roadmap paper has been compiled for first stage editing. These will be available for the next Consortium meeting in early December for review and discussion before further consultation is undertaken. https://www.anpc.asn.au/healthy-seeds/

The first achievement of the Healthy Seeds project was the launch of The Australian Native Seed Survey Report on 31 March 2020 by the Threatened Species Commissioner Dr Sally Box. This ANPC report authored by Martin Driver, Dr Paul Gibson-Roy, Dr Linda Broadhurst and Dr Nola Hancock details the full results of a national survey capturing the behaviours and views of a wide range of native seed sector participants and which fed into the development of the Healthy Seeds project. Between October 2016 and April 2017, the ANPC undertook a survey of the Australian native seed sector, which reported dwindling seed supplies and a decline in expertise and training. Thanks to the authors for their enormous efforts to help understand this critical and complex part of plant restoration. https://www.anpc.asn.au/news/anpcs-australian-native-seed-survey-report-released/

An audit and investigation into past and current Seed Production Areas (SPAs) in NSW has also been undertaken by Murray Local Land Services. The audit investigated the availability of existing infrastructure (such as seed banks), and regional resources (such as local seed databases, vegetation guides and plant lists). It assessed whether the volume and species of seed grown in existing SPAs is sufficient and appropriate in different regions and undertook an investigation to explore barriers and opportunities in the seed and restoration sectors. Some of the key findings of the audit were that few actively managed SPAs were found, there is a current lack of sustained funding for seed banks, demand for seed is

inconsistent and unpredictable due to funding variability, and there is poor understanding of licencing permits and conditions.

A long overdue update of the Florabank Guidelines for best practice native seed collection and use is currently underway, led by ANPC project manager, Dr Lucy Commander as part of the Healthy Seeds project. A reference group has been formed, and the new list of 15 modules developed. We expect the revised and updated Florabank Guidelines to be finalised and launched in 2021. A large number of experts across the seed sector have been consulted, and we appreciate their generous contributions. Florabank workshops and training are being planned to communicate the content, with format and time yet to be confirmed. A draft 'Model Systems for Native Seed' is also being developed as part of the Guidelines in consultation with the Healthy Seeds Consortium. This will be a model code of practice for the seed industry and will be distributed widely for feedback before being finalised.
https://www.anpc.asn.au/florabank/

In 2020, we commenced a comprehensive review and update of the ANPC's Germplasm Guidelines with the support of The Ian Potter Foundation's Environment and Conservation grant, led by Dr Amelia Martyn Yenson. Our flagship publication *'Plant Germplasm Conservation in Australia - strategies and guidelines for developing, managing and utilising ex situ collections'* remains the definitive Australian standard for management of *ex situ* (off site) collections of seeds, plant tissue and whole plants following publication of the 2nd edition in 2009. Since that time, research into the collection, curation and utilisation of *ex situ* collections has progressed significantly and we want to ensure the latest information is passed onto practitioners including scientists, conservation agencies, threatened species staff, regional botanic gardens, NRM bodies and conservation groups and land managers. We have brought together leading experts in seed banking, living collections, tissue culture and cryopreservation research and practice from across Australia and New Zealand to review and rewrite the Guidelines. By continuing to incorporate updated scientific knowledge in our publications we are ensuring that Australia's conservation sector has the necessary skills and knowledge to support *ex situ* collections of common and threatened species. A steering committee has been established and more than fifty scientists, seedbank staff, horticulturists and botanic gardens staff have been consulted from across Australia and New Zealand to ensure that the Guidelines are underpinned by the latest scientific findings. Contributions towards draft chapters and case studies are going well. To date, 12 out of 15 chapters and 38 out of 50 case studies have been received. Drafts will be circulated in late 2020 for review. We are on track to complete the review by mid-2021 with an online launch at Australasian Seed Science Conference in September 2021. Online training materials for the Germplasm Guidelines will then be developed.
https://www.anpc.asn.au/germplasm-guidelines-review/

I am pleased to announce that the ANPC received funding this year from San Diego Zoo Global (SDZG), with encouragement from the US Center for Plant Conservation. The grant will focus on preventing plant decline and extinction and reducing the impacts of future fires in eastern Australia. Narrow-range endemics and priority threatened plant species most sensitive to having recovery disrupted by repeated fires will be identified under this four-year project. Field inspections will quantify recovery and identify threats that need amelioration. Seed and/or vegetative germplasm will be collected and established at state and regional botanic gardens where appropriate. These plant conservation actions align with the recommendations of the Federal Threatened Species Scientific Committee for Post-fire Recovery to: 1) Prevent extinction and limit decline of native species and ecosystems affected by the 2019-20 fires, and 2) Reduce impacts from future fires.
https://www.anpc.asn.au/prevent-rare-plant-extinction-and-reduce-impacts-of-future-fires/

Our new Fire and Rust project, funded by the Threatened Species Recovery Hub, aims to determine the susceptibility and impact of Myrtle Rust on Myrtaceae species regenerating after the bushfires. In cooperation with the Department of Agriculture and Fisheries Queensland and the NSW Department of Primary Industries, locations across fire affected regions in NSW and Queensland (including reserves in the Gondwana Rainforests of Australia World Heritage area) are being targeted with general surveys to capture data across a range of sites and species. Short term impact assessment plots have been established at selected sites and data recorded on disease progression/species decline rates. The project will identify the species showing susceptibility and the regeneration forms (re-shoots/seedlings) affected by Myrtle Rust. The effect of repeated infection on species recovery/survival will be determined for species highlighted in priority lists, including bushfire affected threatened plants. Preliminary surveys suggest species not normally seen as susceptible in undisturbed sites are becoming infected and impacted by Myrtle Rust. The final report on this project will be out soon.
https://www.anpc.asn.au/fire-and-rust/

The ANPC received a Biodiversity Conservation grant from the Ross Trust for two years from June 2020. The "Plants Going Places" grant will address the need to educate and inform both environmental scientists and practitioners on the translocation of threatened plants, for the benefit of Victoria's threatened plant species. In 2021 or 2022, the project will present three, one-day plant translocation workshops in Melbourne, Ballarat and Bairnsdale. In addition, three video site tours will be produced with accompanying public podcasts, which

will explore the stories of past and current translocation projects through the eyes of practitioners to investigate "What makes a translocation successful?". The aim of the project is to build capacity to successfully undertake translocations in Victoria (especially critical to post-fire recovery), increase awareness of threatened plants, help tackle 'plant blindness', and give voice to those people who work in this underappreciated field. We appreciate the in-kind support being provided by the Royal Botanic Gardens Victoria, Federation University Australia and Greening Australia (Bairnsdale) for this project. https://www.anpc.asn.au/plants-going-places/

The ANPC was also part of two teams that were successful in obtaining funding from grants under the federal government's Wildlife and Habitat Bushfire Recovery Program. The ANPC will firstly coordinate an Orchid Symposium, in collaboration with La Trobe University on their post-fire orchid project, planned to be held online in June 2021. Secondly, the ANPC will carry out project communications and publicity, in collaboration with the Australian Seed Bank Partnership, on their 'Banking on seeds for bushfire recovery – Insuring against future loss' project.

We finalised the Norman Wettenhall Foundation biodiversity conservation grant this year for Stage 2 of the Bringing Back the Banksias project. This project has funded a networking, coordinating and communications role at the ANPC between researchers and practitioners to improve the conservation status of Silver Banksia (*Banksia marginata*) throughout south-western NSW and across Victoria, where it has mostly disappeared from the landscape over agricultural areas. It has enabled further Silver Banksia collections to be sampled from relict populations or plants for analysis in conjunction with The Royal Botanic Gardens Sydney '*Restore and Renew*' project. Genetic analysis is still to be completed and cross referenced with sub-samples from the previously completed Victorian projects.
https://www.anpc.asn.au/banksias/

Over the past 12 months, the ANPC has continued its collaboration with the Orchid Conservation Program at the Royal Botanic Gardens Victoria (RBGV) on two projects. The *Saving the Threatened Audas Spider-orchid (*Caladenia audasii*) from extinction* project funded by DELWP in 2017 has resulted in seed collection and propagation of seedlings, hand pollination of wild plants, plant surveys and pollinator baiting, and the construction of an exclusion fence to protect newly discovered plants from grazing kangaroos and rabbits. This project will finish in June 2021 with the re-introduction of 200 plants (postponed due to COVID-19). In 2018, DELWP also funded a similar project *Saving the Brilliant Sun Orchid (*Thelymitra mackibbinii*) from extinction*. Two herbivore exclusion fences have been constructed and plant and pollinator surveys have been undertaken. Community volunteers have been assisting with the surveys and will reintroduce 400 propagated seedlings in Winter 2021.
https://www.anpc.asn.au/audas_spider-orchid/
https://www.anpc.asn.au/brilliant_sun-orchid/

Submissions

This year the ANPC made a submission in relation to the independent review of the Environment Protection and Conservation Act 1999 (EPBC Act). https://www.anpc.asn.au/wp-content/uploads/2020/04/ANPC-EPBC-Act-review-comments-20-April-2020.pdf

In addition, in November 2020, I am attending a virtual workshop on the development of the Australian Government's new Threatened Species Strategy. The Threatened Species Commissioner, Dr Sally Box, is developing a new ten-year strategy to increase security and support recovery of Australia's threatened species and is seeking views on the draft framework of the new Strategy. This will provide us the opportunity to reflect on the current Threatened Species Strategy (2015-2020) as far as threatened plants are concerned, including opportunities for improvement, and to discuss possible prioritisation principles (how priority species and places might be selected for inclusion) under the new Strategy and what action areas should be the focus for the Australian Government and its partners.
http://www.environment.gov.au/biodiversity/threatened/publications/threatened-species-strategy

ANPC committee members will soon be attending the on-line 2020 National Biosecurity Forum being held by the Department of Agriculture, Water and the Environment and the National Biosecurity Committee. It is an opportunity to discuss biosecurity challenges, achievements and future directions.

APCC13 Conference

Unfortunately, the 13th Australasian Plant Conservation Conference which was due to be held in April 2021 in Albury, has been postponed to April 2022 due to COVID-19. This has had some impacts on the Healthy Seeds project as presentations and the launch of the Florabank Guidelines had been planned for the conference. Instead, we are investigating holding virtual launches/presentations around that time, and to virtually seek feedback and stakeholder engagement with the sector across the country when we are further advanced on the Roadmap.

I would like to thank the conference organising committee for all their time and work to date on planning what will eventually be an exciting conference: Ros Walls and Jason Kimball (AlburyCity); Phil Falcke (North East CMA); Jim Begley (Goulburn Broken CMA); Jodi Price (Charles Sturt Uni); Damian Wrigley (ASBP); Sue Logie (Murray LLS); Singarayer Florentine (Federation Uni);

Judy Kirk (Wooragee Landcare); and ANPC staff Martin Driver, Lucy Commander, Amelia Martyn Yenson, Christine Fernance and Jo Lynch. We will pick up from where we left off around April/May 2021. https://www.anpc.asn.au/conferences/apcc13/

Workshops and Outreach

Unfortunately, the drought, then 2019/20 bushfires and then COVID-19 have affected our ability to undertaken face-to-face workshops over the last year. A two-day workshop planned for April 2020 with germplasm experts for the Germplasm Guidelines review had to be postponed. A successful funding application from the Australian Academy of Science to hold a Fenner Conference on the Environment will provide additional funding for this workshop. The conference format and date will be confirmed in early 2021. Additionally, four in-person Germplasm workshops funded by the The Ian Potter Foundation grant can hopefully be held before June 2022 (a six-month extension has already been granted).

One COVID-19 friendly Native Plant ID, management and establishment workshop was held in October for Riverina LLS, for a maximum invited group of 20 graziers, Landcare staff and managers. Despite the continuing uncertainties we have had three early stage requests for running Native Plant ID, Seed and management workshops in western NSW in 2021 (subject to all eventualities).

Because of COVID-19, delays in genetic analysis and now the postponement of the ANPC Conference, the final Bring Back the Banksias Project workshop presentation to communicate findings and implications that was originally proposed for 2020 was deferred. However, once the latest genetic results are written up by the various partners of the project, they will be published in *Australasian Plant Conservation*.

We were also collaborating with the Australian Seed Bank Partnership to plan the Australasian Seed Science Conference which was to be held in Canberra 5-9 April 2020. Unfortunately, three weeks out from the conference, it was postponed to September 2021 due to COVID-19. https://seedscience2021.com.au/

Australasian Plant Conservation (APC), ANPC's quarterly bulletin, has continued to publish high-quality articles relevant to a broad range of plant conservation practitioners and managers, under the editorship this year of Heidi Zimmer and assistant editors Nathan Emery and Selga Harrington. This year, APC has featured articles on pollination, plant responses to fire, seed biology, orchids, translocation, *ex situ* conservation, Myrtle Rust and more, including papers from university students. I sincerely thank Heidi, Nathan and Selga and volunteer proof-readers for their efforts over the past year in ensuring that APC continues to be a quality and well-respected publication communicating Australasian plant conservation issues. I also welcome Tom Le Breton who has taken on the role of compiling the Research Roundup for APC. Thank you also to the many authors who have contributed to these editions this year. https://www.anpc.asn.au/apc/

Our outreach efforts continue to expand through social media with the regular sharing of news and events in plant conservation via Twitter, Facebook, Instagram and LinkedIn. Our monthly email newsletter *ANPC News* continues to reach at least 630 subscribers. The new ANPC website was expanded to include post-fire resource webpages. https://www.anpc.asn.au/plants-and-fire-2020/ and https://www.anpc.asn.au/bushfire-2019-2020-resource-page-2/

Drs Lucy Commander and Heidi Zimmer wrote a highly topical article on the impacts of the fires on plants for *The Conversation.* https://theconversation.com/yes-native-plants-can-flourish-after-bushfire-but-theres-only-so-much-hardship-they-can-take-129748.

Lucy also presented on the Translocation Guidelines in a video produced by the Threatened Species Recovery Hub. https://www.youtube.com/watch?v=Rfgse5qKdy4andfeature=youtu.be and was interviewed on translocation and seeds for STEAM Powered. https://www.youtube.com/watch?v=wYl8799VOXMandfeature=youtu.be

Committee member Dr Paul Gibson-Roy participated in two radio conversations related to the Seed Survey Report: https://www.anpc.asn.au/uncategorized/dr-paul-gibson-roy-talks-about-seed-supply-for-restoration-projects/ https://eastsidefm.org/podcast/farming-wildflowers-the-future-of-resoration-and-native-seed/.

In 2020, we continued distributing the 3rd edition of the ANPC's '*Guidelines for Translocation of Threatened Plants in Australia*' which was released in 2018 – 7 hard copies and 8 downloads. It already has 15 citations in the literature, and is essential reading for all those involved in translocation projects both in Australia and elsewhere, to remain at the cutting edge of this important technique used in the fight against plant extinctions. https://www.anpc.asn.au/translocation/

Staffing

Many thanks to all our staff who work above and beyond the call of duty for the ANPC. Their dedication, advice and support make my role and the work of the Committee much more effective and ensures that the ANPC continues to function as a highly respected conservation organisation. I look forward to seeing the results of their excellent work in 2021. Fortunately, COVID-19 didn't affect our staff too much this year, as they were either easily able to, or were already working remotely.

Martin Driver has continued this year in his capacity as the Healthy Seeds Project Manager coordinating and managing the Healthy Seeds project, developing the Roadmap and overseeing the SPA audit and investigation reports and Florabank Guidelines update. He has also been consulting and liaising with stakeholders, Consortium members, other experts (scientists and practitioners) and community representatives from a range of organisations.

Dr Lucy Commander has led the review of the Florabank Guidelines, assisted Martin in the development of the Roadmap and is working on the draft 'Model Systems for Native Seed'. She will also be involved with the coordination of the online Orchid Symposium in June 2021 and the three threatened plant translocation workshops in Victoria (probably in 2022).

Both Martin and Lucy have also been engaged on a pro-rata basis by Greening Australia through the ANPC, to assist with liaison and the implementation of their federally funded bushfire recovery Project Phoenix, on issues that are related but not directly aligned to either Healthy Seeds or Florabank outputs. Lucy has started writing a desktop review of published reports on the Australia Seed Sector. GA's consultant market economist is also currently reviewing the 'Model Systems for Native Seed' for the seed market and providing input to elements of the Florabank Guidelines that align with Project Phoenix.

In February, Dr Amelia Martyn Yenson joined us in the role of Project Manager for the Germplasm Guidelines review. With a background in seed research at the Royal Botanic Gardens and Domain Trust, she has elicited strong support for the revision from the *ex situ* conservation community. Amelia is also starting to plan how to best promote and implement the Guidelines once they are published, with a 2-day expert workshop and online learning tools, and has assisted with the review of the draft FloraBank Guidelines.

In June 2020, Christine Fernance started in the exciting new position of ANPC Communications Manager. Christine has a background in Marine Science and Management and is currently completing a Master of Science Communication at ANU. She has hit the ground running with managing all the ANPC's social media, ANPC News e-newsletter, project promotions, and recently drafting an ANPC Communications Strategy.

Our Business Manager, Jo Lynch, has continued her excellent work in the office with successful applications for numerous grants, along with project and budget management. Sincere thanks to our office volunteer Robert Hawes, who has helped enormously with various administrative and financial tasks this year, especially in the absence of a Treasurer. Unfortunately, no one nominated for Treasurer at the last AGM. Via advertising in social media and through an ACT volunteer organisation, retired accountant John Grunberg nominated for the position in May this year, but subsequently had to resign due to health reasons.

I am grateful to all the Committee members for their tremendous support over the year. They all have significant commitments outside the ANPC, and it is often challenging to devote the time required to be active committee members. The involvement in the committee by all members is a clear demonstration of their dedication to the ANPC and its goals in improving plant conservation.

I would especially like to thank Dr Cathy Offord and Chantelle Doyle who are leaving the committee this year, as well as Melissa Millar who is stepping down as Secretary after serving her limit of four years, but is re-standing as an Ordinary Member. I sincerely thank them for their time and support during their respective tenures.

Funding

Our financial situation will be reported on in detail separately at the AGM but some of our keys sources of income this year have included:

- NSW Environmental Trust Healthy Seeds project.
- The Ian Potter Foundation Environment and Conservation grant for the review of the Germplasm Guidelines.
- Greening Australia's Project Phoenix
- The Ross Trust Biodiversity Conservation grant 'Plants Going Places' project
- San Diego Zoo Global project to 'Prevent Rare Plant Extinction and Reduce Impacts of Future Fires in eastern Australia'
- NESP Threatened Species Recovery Hub 'Fire and Rust' project.
- Biodiversity On-ground Action 2017 - Community and Volunteer Action Grant (Victoria) for "Saving the threatened Audas Spider-orchid (*Caladenia audasii*) from extinction".
- Biodiversity On-ground Action 2018 - Community and Volunteer Action Grant (Victoria) for "Saving the Brilliant Sun Orchid (*Thelymitra mackibbinii*) from extinction".
- Memberships and donations.

I would like to thank all the ANPC staff, as well as committee members, for their efforts in seeking funding and grants – while not every application is successful, we rely heavily on their efforts to continue to seek funding to support our key activities.

The hosting of the ANPC by the Australian National Botanic Gardens remains a crucial support for us, and a major contribution by the ANBG to the national effort for plant conservation. This includes provision of office space, computers, phones, electricity, furniture, and a printer. I would like to sincerely thank the Gardens for this support, and look forward to continuing this close relationship into the future.

The coming year

2021 will be a very busy year for the ANPC undertaking the following activities:

- Finalising the Healthy Seeds Project including producing the Roadmap and Florabank Guidelines.
- Finalising the review and launching the 3rd edition of the Germplasm Guidelines.
- Undertaking the two bushfire related projects.
- Producing three online plant translocation videos in Victoria.
- Planning the three translocation workshops in Victoria.
- Coordinating an online Orchid Symposium for June.
- Planning the two-day Germplasm expert workshop for the Australian Academy of Science Fenner Conference on the Environment grant.
- Planning the 13th Australasian Plant Conservation Conference for April 2022.
- Seeking additional funding for further projects and workshops.
- Finalising the two orchid projects with RBGV.

I have really enjoyed my time as President over the last year. It was good to see how well ANPC works when dealing with emerging conservation issues such as the impacts of the 2019/20 bushfires and ongoing issues like the global biodiversity extinction crisis. I think that shows the ongoing strength of the organisation and the value for people and communities to stay connected and share knowledge to overcome challenges. It has been a pleasure and a privilege to work with all of you and for an organisation that does so much for plant conservation in Australia. With ongoing recovery and restoration after the 2019/20 fires and 2021 ushering in the UN Decade of Ecosystem Restoration, I see a continuing important future for the ANPC in plant conservation across Australia and the region more broadly.

The ability to resprout basally enables the endangered *Macadamia jansenii* to survive fire

GLENN HAYWARD* AND ALISON SHAPCOTT

University of the Sunshine Coast, 90 Sippy Downs Dr, Sippy Downs QLD 4556
*Corresponding author: gwh003@student.usc.edu.au

Background

The extensive 2019-2020 Australian bush fire season impacted a variety of ecosystems including rainforests, which are generally not fire adapted. However, due to warming climates and drought conditions, some rainforests became prone to being burnt. During the 2019-2020 fire season many rainforest habitats burnt across Australia including the rainforest in Bulburin National Park. Bulburin National Park is home to many endemic rainforest species including the endangered *Macadamia jansenii* (Shapcott and Powell 2011). *Macadamia jansenii* occurs along riparian rainforest (Araucarian microphyll vineforest) on granite colluvium substrate. In 2009, this species was only known from a small population of roughly 60 individuals located in a single location (Shapcott and Powell 2011). *Macadamia jansenii* has gained a lot of attention due to its restricted distribution and population size and has an active recovery plan (Costello et al 2008; Shapcott 2019). Due to its restricted distribution, the species was selected as one of the top 30 priority threatened plant species targeted by Australia's threatened species strategy for 2020. It has also gained interest from the Macadamia horticultural industry due to its northern distribution, potentially aiding in adaptions to warmer climatic conditions. This could be a valuable attribute for the Macadamia industry in the face of climate change.

During the 2019 Australian fire season a large area of the Bulburin National Park was burnt, with a large proportion of *M. jansenii* habitat being directly impacted. The post-fire response of Proteaceae species has been studied predominantly in fire-prone habitats, such as heath vegetation. However, the effect of fire on rainforest habitats is poorly understood, and impacts on specific species even less so.

Discovery of new populations

The known population size of *M. jansenii* roughly tripled after the discovery of new populations (pre-fire) in 2019, as a result of extensive survey (Hayward 2020a). In addition, the reintroduction program for *M. jansenii,* which was implemented 10 years ago (Shapcott 2019), has resulted in an increase in overall population size of approximately 10%, potentially adding viability to the wild population (Hayward 2020a). However, despite the increase in known wild population size, and the insurance population, the species is still very restricted in its distribution and population size, making it vulnerable to chance events. We also observed a decline in the original population between 2009-2019, increasing concerns for the survival of the species (Hayward 2020a).

The impacts of fire on the restricted population

We resurveyed *M. jansenii* in July 2020, approximately three months after the fires , to allow time for post-fire regeneration. Our ground survey found that the fires were patchy often with small areas being burnt. Where fires had burnt, there was usually evidence of leaf scorching, rather than leaves being burnt. It appeared that the fires had burnt the leaf litter layer and seedling layer, with evidence of charring mostly within the first 30 cm above the ground (evidenced by charring on tree trunks) indicating low fire intensity (Hayward 2020b). Additionally, remote sensed fire severity mapping confirmed the fire was low severity, with some high intensity areas, within Bulburin National Park (Thorley 2020). Where high severity fires occurred, adult trees were killed. In areas where the fire was of lower severity, the predominant impact was on seedlings.

The team helping to survey *Macadamia jansenii* in 2019 prior to the fires. Left to right: Alison Shapcott, Liang Ansel Lee, Glenn Hayward, Keith Sarnadsky, Gidarjil Caring for Country Rangers, Darren Brown, Noa Fletcher, and Ric Fennessy, lastly Ray Johnson in front.



Left to right: Figure 1. Reintroduced plant which was scorched by proximity of recent bush fires. This particular individual had resprouted from the base post fire. With recent rains providing promising conditions for the post fire environment. Figure 2. A mature plant which is resprouting from multiple locations post fire. The canopy on this individual was dead making this one of the vulnerable plants. Figure 3. Even plants of less than 1 m in height were observed to resprout post fire. This individual has healthy new growth post fire. Photos: Glenn Hayward

There was considerable evidence of resprouting by many species in the area, including *Macadamia jansenii.* There was also evidence of new germination of seedlings of some canopy and lower strata species, particularly monocotyledons such as ginger and cordylines, as well as soft herbaceous species including some weeds.

We were able to successfully relocate all *M. jansenii* plants found during our previous survey (25/10/2019). We found that two thirds of the population were directly impacted by the fires. However, due to the patchiness of the fires, many plants avoided direct impacts (Figure 4). However, the post-fire on-ground resurvey results show a significant decline in population size. The majority of the dead plants were seedlings, showing that the seedling age class is the most vulnerable to fire. Some larger trees were also significantly impacted, resulting in the mortality of important, mature, seed-producing trees (Figure 5). Additionally, many fire-impacted *M. jansenii* lost canopy cover - these individuals are predicted to have a lower fruit set in the coming years due to the damage caused by the fires. The post-fire survey confirmed 83% of the wild population had survived the fires and, of the sites that were burned, 77% of the plants survived (Hayward 2020b).

Additionally, of the four insurance populations only one population was directly impacted by the recent fires. In the impacted population, only one individual was scorched by the fires, and this individual was resprouting from the base (Figure 1) (Hayward 2020b).

The ability to resprout

Before the fire, the wild populations of *M. janesii* adult trees were observed to be multi-stemmed. This differs from other Macadamia species, which are usually single stemmed or have a main, dominant stem (Figure 4). We had wondered if this multi-stemmed habit was a response to low nutrients, or historical fire, flooding, or other disturbances. Of the directly impacted plants, one third were fire affected but alive and reshooting basally (Figure 2). Even seedlings were observed to reshoot (Figure 3). Our results confirm that basal regeneration is a mechanism for post-fire survival in this species. We did not; however, observe epicormic resprouting along stems. This ability for the species to abundantly reshoot has clearly enabled this species to survive these recent bush fires and may enable future persistence if fire frequency does not increase.

However, of the resprouting plants, some were only alive as basal sprouts and so are considered vulnerable to short interval, repeat fire which, overall, makes a considerable portion (estimated to be 9%) of the entire *M. jansenii* population vulnerable. These plants will be vulnerable to damage and mortality through drought or potential flooding in the coming months, while they remain small. Due to the fires causing death and scorching foliage of many individuals, we are predicting a lower than usual seed set in the coming fruiting season, which will delay the recovery of this species post fire. It will take years for fire-affected plants to recover and resume flowering to pre fire flower levels (Figure 6).

Acknowledgements

I'd like to acknowledge Alison Shapcott, Catherine Nock, Yoko Shimizu who have helped out extensively with the research, lab work, and helped guide me through my Honours degree. The University of the Sunshine Coast where I completed my Honours study. The department of Environment and Science for funding the post fire surveys. Queensland Parks and Wildlife Service for helping with the earlier surveys and most importantly the indigenous custodians the Gidarjil for their continued support of this project, especially all the Gidarjil Caring for Country Rangers that helped out with the field surveys. The Macadamia Conservation Committee for their continued support surrounding this species. Also, I'd like to thank Keith Sarnadsky and Ray Johnson for there continued efforts for the search of new populations of *Macadamia jansenii.*

National parks research permit number- PTU 19-002096

Figure 4. A very healthy multistemmed *Macadamia jansenii* post fire. This plant was not directly impacted by the fires. Photo: Glenn Hayward

Figure 5. One of the larger individuals lost during the fires. This individual being a large multi stemmed mature *M. jansenii* that unfortunately has not survived the fires. The loss of these larger individuals will reduce species recruitment in the coming years. Photo: Glenn Hayward

References

Hayward, G. (2020a). *Demographic, population genetics, habitat model, and population viability analyses assist in the assessment and future planning of a reintroduction of the endangered rainforest species* Macadamia jansenii *(Proteaceae)*. Thesis for Bachelor of Science (Honours), University of the Sunshine Coast, QLD.

Hayward, G., Nock, C., Shimizu, Y., Shapcott, A. (2020b). Demographic, population genetics, population viability analysis, and habitat model assist in the assessment and future planning of a reintroduction of the endangered rainforest species, *Macadamia jansenii* (Proteaceae) post fire. *Australian Journal of Botany* (Submitted).

Powell, M. and Gould, L. (2019). *DRAFT Macadamia Species Recovery Plan 2019 - 2024*. Department of the Environment and Energy. Available at: https://www.environment.gov.au/biodiversity/threatened/recovery-plans/comment/draft-recovery-plan-macadamia-species-2019-24

Shapcott, A. and Powell, M. (2011). Demographic structure, genetic diversity and habitat distribution of the endangered, Australian rainforest tree *Macadamia jansenii* help facilitate an introduction program. *Australian Journal of Botany* 59: 215-225.

Shapcott, A. (2019). *Threatened plant translocation case study:* Macadamia jansenii *(Bulburin nut), Proteaceae*. In: Commander, L.E., Coates, D.J., Broadhurst, L., Offord, C.A., Makinson R.O. and Matthes, M. (Eds.). Guidelines for the Translocation of Threatened Plants in Australia (3rd ed). pp. 21-23. Australian Network for Plant Conservation, Canberra.

Thorley, J. (2020). *What types of rainforest burnt in the South East Queensland black summer fires?* Thesis for Bachelor of Science (Honours), University of the Sunshine Coast, QLD.

Figure 6. *Macadamia jansenii* flowering high up in the canopy pre fire in 2019. Photo: Glenn Hayward

How the severe fires of 2019-2020 promoted regeneration of the rare Bendethera Shrublands

MARK TOZER[1,2*], MARK OOI[2], CHRIS SIMPSON[2], KATY WILKINS[2] AND PHIL ZYLSTRA[3]

[1]NSW Department of Planning, Industry and Environment
[2]University of NSW
[3]University of Wollongong
*Corresponding author: Mark.Tozer@environment.nsw.gov.au

The Bendethera Shrublands are a unique and fascinating ecological community restricted to less than 100 hectares on a series of steep limestone outcrops in the Deua River valley. The community is characterised by a dense shrub layer to around 7.5 metres height and dominated by *Acacia covenyi,* a locally endemic species, whose blue foliage forms a striking contrast with adjacent *Eucalyptus* forests (Figure 1a). Scattered eucalypts and kurrajongs emerge above the shrub thicket in places, the latter, according to conventional wisdom, indicating the location of dolines (a shallow, funnel-shaped depression of the ground surface, typically found in karst/limestone regions) in the underlying bedrock. The shrublands were located within the epicentre of some of the most severely burnt areas of the south coast. The fires were preceded by prolonged drought and followed by intense rainfall. We evaluated the impacts of these factors when we returned to our established monitoring sites in November 2020.

Ecological characteristics of Acacia shrublands

The Bendethera shrublands are a form of Dry Acacia Shrublands, a type of vegetation unusual in temperate humid south east Australia being dominated by Acacias rather than Eucalypts, and distinctly different from more open Acacia shrublands of Australia's semi-arid and arid climates (Keith 2004). Acacia shrublands of temperate humid climates occupy small isolated patches in rugged mountainous country, usually on exposed rocky slopes with shallow or skeletal soils. These sites are thought to retain too little moisture to support Eucalypt forests, drawing comparisons with Acacia- dominated communities west of the divide (Costin 1954) – semi-arid oases in otherwise temperate climes. Like their western counterparts, Dry Acacia Shrublands are moderately tall (5-20 m) and establish dense canopies with a relatively sparse ground cover. One major point of distinction is the dependence of the eastern Dry Acacia Shrublands on fire for regeneration. The dominant Acacia species are killed by fire and recruit seedlings *en masse* in response to soil heat fluxes during fire which break seed dormancy. Dense, even-aged stands establish following fire, gradually thinning over the course of their lifespan, estimated to be up to 100 years (Clayton-Green and Wimbush 1988, Hunter 2005). Paradoxically, the paucity of ground cover and small shrubs is not conducive to either the spread of fire or the generation of soil heat-fluxes sufficient to break dormancy (Bradstock and Auld 1995). In fact, anecdotal evidence suggests wildfires of low to moderate intensity tend not to penetrate the Eucalypt-Acacia boundary at all and attempts to ignite the shrublands using aerial incendiary have so-far proved unsuccessful (Clayton-Green and Wimbush 1988).

History of fire in the Bendethera shrublands

Prior to 2020, the last known fire in the Bendethera shrublands occurred in the summer of 1968-69 under circumstances strikingly similar to those of 2019-20. That fire was preceded by a prolonged drought, culminating in rainfall less than half the annual average recorded in 1968. Severe fire weather prevailed over a season extending from early September to late March and, as in the recent fires, extensive areas of the southern coast and ranges were burnt, including forest and rainforest communities which rarely burn under normal conditions (Duggin 1976). Fire history prior to 1969 is uncertain. Wallis (1965) commented that, at the time of his visit, the caves were difficult to access due to dense post-fire regrowth, so it is possible the shrublands burnt in fires which occurred in the area over the summers of 1938-39 or 1953-54 (Duggin 1976). A number of fires have occurred in the area since 1968, most notably a major wild-fire in the summer of 2001-02 which self-extinguished at the boundary of the shrublands.

Pre-fire conditions

Aerial photographs combined with the present structure of the heathland indicate Acacias re-established at high densities following the 1968 fire and have undergone self-thinning over an extended period. From 2006 up until the time of the fire, significant senescence, augmented by lightning strikes and wind damage, initiated a gradual transformation of the shrublands. Parts of the upper slopes became bare or supported only scattered shrub cover with little or no groundcover (Figure 1b). On the mid-slopes Acacias were gradually replaced by shrub species able to establish in the absence of fire, such as *Beyeria lasiocarpa* and *Myoporum acuminatum*. Acacias disappeared from the lower slopes almost

Figure 1. A) Characteristic blue foliage of *Acacia covenyi* (seedlings) contrasting with burnt eucalypt forests in the background; B) Prior to the fire, senescence of *Acacias* created gaps in the shrub canopy; C) Flora monitoring plot in dense shrubland prior to the fire; D) The same plot after the fire. *Scaevola albida* has colonised the site while *A. covenyi* seedlings are too small to see (cf Figure 2), the first cohort having been washed away ; E) *Melaleuca armillaris* seedbanks only survived on plants growing within rock outcrops; F) Seedlings of *M. armillaris* re-establishing within a rock outcrop. Photos: Mark Tozer (A, C, D, E, F); Chris Simpson (B)

entirely, replaced by a dense herbaceous groundcover undoubtably sustained by groundwater seepage. These changes were not necessarily irreversible because other *Acacia* species typically establish dormant, long-lived seedbanks. However, because of the lack of ground-fuel on the upper-slopes and the fact that Acacia shrublands are notoriously non-flammable, the fate of the community was uncertain.

Impacts of the fire

High intensity fire typically precipitates a stunning transformation in heath and shrublands, turning impenetrable thickets of green to a sea of blackened, skeletal remains. What we observed in our plots was extraordinary for the almost complete absence of woody remains (Figures 1c,1d). This is testimony to the exceptional intensity of the fire, but also a particular feature of the shrublands. While the canopy foliage in our plots was generally continuous, the structure of the population suggested this was maintained by ever-decreasing numbers of live plants which were progressively increasing in size. Smaller plants remained standing following death to the extent that in 2015, the ratio of dead to live plants ranged from 1.2–2.6 and may have been higher at the time of the fire following three years of drought. We suggest this created conditions for a fire of exceptionally high severity and long residence-times as the canopy collapsed and continued to burn on the ground. The very high densities of *Acacia* seedlings that emerged following the fire are consistent with a significant soil heat flux (Figures 2, 3). Surprisingly, we even recorded reasonable seedling densities in areas bare of fuel prior to the fire. The heating required to drive this may have come from movement of coarse woody debris during the fire storm, the 'attachment' of flames to the steep slopes due to strong up-slope wind driving convective heating (Zylstra in review) or by solar insolation in the weeks following fire (Santana *et al*. 2010).

Kill thy Neighbour?

One interesting outcome of the fire was declines in populations of species with serotinous seedbanks. No seed capsules remained on any *Hakea eriantha* (an obligate seeder) marked prior to the fire (in fact the plants themselves were wholly consumed) and we conclude the species is likely to have been eliminated from the site. A similar fate befell individuals of *Melaleuca armillaris* (facultative resprouter), which neither resprouted nor retained a seedbank except when they were surrounded by extensive rock outcrops which afforded some protection (Figures 1e, 1f). It seems that dense, prolifically branching stands of *Acacia covenyi*

Figure 2. Dense seedling recruitment of *Acacia covenyi* with *Brachychiton populneus* resprouting in the background. Although *Brachychiton* individuals show extensive fire-damage and have been slow to recover, we recorded mortality of only 2% in the first year post-fire. Photo: Mark Tozer

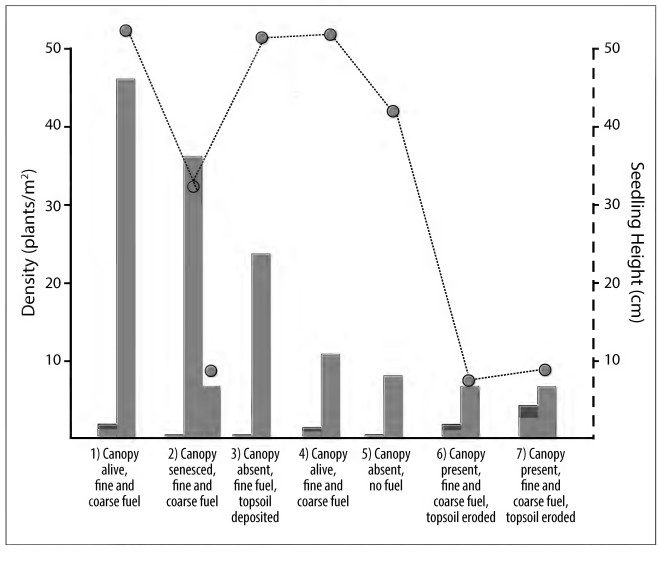


Figure 3. Densities (bars, left axis) of *Acacia covenyi* adults (live – dark blue, dead – red) prior to the 2019-2020 fires and density of seedlings (*A. covenyi* – light blue, *Beyeria lasiocarpa* – green) following the fires. Average seedling heights are represented as circles (right axis).

can, under the right conditions, support fires of sufficient intensity to reduce populations of potential competitors. Bond and Midgley (1995) proposed this mechanism of neighbour mortality as a means by which some pyrogenic species might maintain occupancy, despite presence of superior competitors represented in the regional species pool. Replacement by *Beyeria lasiocarpa* and *Myoporum acuminatum* was also reversed following the fire, although while the latter species has almost entirely disappeared, the former has persisted, albeit at much lower densities than *A. covenyi* and with less vigorous growth rates (Figure 3).

….of flooding rains

On February 10, coastal settlements on the NSW south coast recorded up to 150 mm of rainfall in the preceding 24 hours. While the exact figures for Bendethera are unknown, we recorded evidence of significant erosion within the shrublands. The stripping of topsoil from the steep upper slopes had several consequences. First, it appears erosion removed much of the seedbank which supported such prolific seedling establishment on more gently sloping areas. Cohorts of seedlings in eroded areas are at significantly lower densities and heights (Figure 3), suggesting seed previously buried deep beneath the surface has only recently germinated, presumably having had dormancy broken by solar insolation during spring (Santana *et al*. 2010). Conversely, the lower slopes of the mountain from which *Acacia covenyi* had disappeared prior to the fire now support dense stands of Acacia on deep colluvium, potentially originating from seed transported from upslope.

Conclusions

While undeniably traumatic, the evidence suggests that the summer of 2019-2020 witnessed a set of circumstances which have maintained the Bendethera Shrublands throughout their history. We suspect that, historically, such events could be cyclical on a multi-decadal scale. Our observations suggest that severe fires must be regular, if infrequent, events in these ecosystems, and it is difficult to imagine how the Bendethera Shrublands could persist in their absence for extended periods. While the palatability of *A. covenyi* seedlings is unknown, severe and extensive fires also reduce herbivore densities in the period when seedlings and juveniles are most vulnerable, which is potentially critical for a species restricted to such a small area.
The main threats to the Bendethera shrublands are twofold. In the aftermath of the fires, erosion of the steep slopes provides opportunities for invasion by exotic species in areas with low levels of recruitment. This is a particular problem in the sub-catchment in which the main cave is located, and so careful management of visitation must be a priority as recovery continues. More broadly, while our investigations commenced in response to concerns about the long-term absence of fire, the events of 2019-2020 serve as a reminder that extreme fire events are projected to become more frequent as a consequence of climate change (Stephens *et al.* 2014; Bowman *et al.* 2017). Further research is required to determine minimum fire-free intervals required to permit persistence of the Bendethera shrublands in their current state.

References

Bond, W.J. and Midgley, J.J. (1995). Kill thy neighbour: an individualistic argument for the evolution of flammability. *Oikos*: 79-85.

Bowman, D.M., Williamson, G.J., Abatzoglou, J.T., Kolden, C.A., Cochrane, M.A. and Smith, A.M. (2017). Human exposure and sensitivity to globally extreme wildfire events. *Nature Ecology and Evolution* 1(3): 1-6.

Bradstock, R.A. and Auld, T.D. (1995). Soil temperatures during experimental bushfires in relation to fire intensity: consequences for legume germination and fire management in south-eastern Australia. *Journal of Applied Ecology* 32: 76-84.

Clayton-Greene, K.A. and Wimbush, D.J. (1988). Acacia dry scrub communities in the Byadbo area of the Snowy Mountains. *Cunninghamia* 2: 9-24.

Costin, A.B. (1954). *A study of the ecosystems of the Monaro region of New South Wales, with special reference to soil erosion*. AH Pettifer, Government printer.

Duggin, J.A. (1976). *Bush fire history of the south coast study area*. Technical Memorandum 76/13. Canberra.

Hunter, J.T. (2005). Floristics and distribution of wattle dry sclerophyll forests and scrubs in north-eastern New South Wales. *Cunninghamia* 9: 317-323.

Keith, D.A. (2004). *Ocean shores to desert dunes: the native vegetation of NSW and the ACT*. Department of Environment and Conservation (NSW).

Santana, V.M., Bradstock, R.A., Ooi, M.K.J., Denham, A.J., Auld, T.D. and Baeza, M.J. (2010). Effects of soil temperature regimes after fire on seed dormancy and germination in six Australian Fabaceae species. *Australian Journal of Botany* 58(7): 539-545.

Stephens, S.L., Burrows, N., Buyantuyev, A., Gray, R.W., Keane, R.E., Kubian, R. and Van Wagtendonk, J.W. (2014). Temperate and boreal forest mega-fires: characteristics and challenges. *Frontiers in Ecology and the Environment* 12(2): 115-122.

Wallis, G.R. (1965). *Report on the Bendithera Caves*. Geological Survey of New South Wales Report 28: 7-10.

Zylstra, P.J. (in review). Linking fire behaviour and its ecological effects to plant traits, using FRaME in R. *Methods in Ecology and Evolution*. Under Review (2021).

Seed orchard research and development at Marrinup Nursery, 1986 to 2015: an additive learning process

DAVID WILLYAMS

Vitroflora Pty Ltd, Woombye, QLD 4559
Marrinup Nursery, Alcoa of Australia: 1992-2015
Corresponding author: davidw@vitroflora.com.au

Editor's note: This article describes the work of Marrinup Nursery, which operated for 36 years from 1980 to 2015. During this period the nursery's methods (and focal species) changed and evolved, leading to invaluable learnings for anyone working in seed orcharding. Enjoy!

Marrinup Nursery developed native plant seed orchards in Western Australia during the period 1986 to 2015, to produce seed for use in Jarrah forest restoration. With 300 to 2,700 kg of wild native seed being collected and broadcast each year (Cromer and Norman 2006), reducing wild seed collection to minimise forest impacts was a priority; especially with declining annual rainfall. From an initially low knowledge base the nursery steadily increased orchard seed production. The lessons learnt improved subsequent Jarrah forest seed orchard outcomes and are worth sharing. Recording and analysing failures led to development of more effective techniques that increased seed production, as the seed orchards progressively increased in scale and complexity. This progressive learning approach minimised the risk and costs.

Tree seed orchards

During the 1990s the nursery focused on native tree seed orchards for saline and alkaline land rehabilitation throughout Western Australia. Salt tolerant *Eucalyptus camaldulensis* orchards were established throughout Australia and overseas locations, with significant input from Marrinup Nursery. Most of these orchards did not supply large amounts of seed as initially the preference was for tissue-cultured plants, while the orchard trees grew. Later it was discovered that the concept of planting salt-tolerant trees, their seedlings, or sowing their seeds to reduce the spread of salinity, was not as effective as alternate approaches, including the restoration of local vegetation. Predicting the need for seed orchards and selecting the appropriate species mix may need to happen alongside relevant research, with changes to accommodate research findings. Otherwise seed supply may be significantly delayed.

A major multi-agency program established a seed supply from orchards of Jarrah (*Eucalyptus marginata*) trees selected as resistant to the aggressive tree disease Phytophthora Dieback (*Phytophthora cinnamomi*). Most of these trees were propagated at Marrinup Nursery (Willyams 2016). Dieback-resistant Jarrah seed orchards were also established in cleared areas throughout the Jarrah forest. These trees had high survival and the seed naturally dispersed into surrounding Dieback-affected forest. Using degraded original forest sites in the Darling Plateau meant the soils and climate were highly amenable. As a notoriously difficult species to establish outside its natural range, establishing one Jarrah orchard on the Swan Coastal Plain had higher risk. In spite of significant investment in land preparation and irrigation, both plant survival and growth were persistently low. The sandy soil proved unsuitable, mainly as it dried out during the summer. The irrigation relied on regular human inspection and repair, which was problematic during long weekends and summer holidays. Today, an automated irrigation system with smartphone alerts could overcome this and is highly recommended. A Dieback Resistant Jarrah seed orchard established at Marrinup Nursery in forest soils had a different soil and water problem. While 19 selected reference trees in the orchard produced 2,061 grams of seed in 2002, by 2007 this had declined to 200 grams. The soils at this initially moist site had dried. Investigation revealed soil water, tree growth, flowering (and thus seed production) was reduced due to an impermeable rock layer at depth. For tree orchards deep soil and regolith profiling is recommended to prove the sites are viable of supporting tree growth to full size.

An issue with all the native tree seed orchards was certain trees producing far higher seed yield than others (up to 300x). As the aim was to return representative genetics to the restored forest then this could have skewed the broadcast seed heavily in favour of a few high producing trees. Using similar size seed quantities per tree for seedmix preparation reduced the total quantity of seed available for restoration each year.

As the onsite tree health continued to decline and the offsite orchards became excessively tall for safe and cost-effective collection then this program went into hiatus. Considering seed collection practicalities and costs at the start of seed orchard development is recommended.

Understorey seed orchards

The seed orchard program progressively increased in scale and complexity to respond to the need for a wide range of Jarrah forest species' seeds for use in restoration seed mixes. At the same time, a steady decrease in rainfall in the Jarrah forest was reducing the amount of seed available for collection. While the nursery's initial in-ground seed orchards produced more seed per plant than wild plants, it was clear that much seed was being shed onto the ground or lost to predators. Disease and drought also thinned out these orchards, allowing weeds to infiltrate the population. Apart from the reduction in seed production there was also the potential for weed seed to contaminate the seed used for forest restoration. Weed presence in the restored areas was undesirable, particularly the extra competition during the early establishment of the native seedlings**.**

Seed orchards in pots

With limited labour, and collection difficulties with the in-ground orchards, new orchards were developed with plants in pots held on the raised nursery growing beds. In 2004 they supplied over 8 kg of seed (Table 1). With these orchard plants being at waist height they were easier to maintain, study, assess seed ripeness and to collect the seed (Figure 1), with a low risk of soil borne diseases. Woody legume species seed collection was problematic as they tended to have explosive seed release, often when no-one was on site. The use of collecting nets below the nursery beds improved seed collection. For multi-branched woody species Rocketpots® or Spring-rings® increased the number of branches leading to higher flower and seed production (Figure 2).

Banksia dallanneyi (syn. *Dryandra lindleyana*) had low seed supply due to very high wild seed predation. A seed orchard in Rocketpots® (Figures 3, 4, 5) had low seed predation and higher seed production per plant compared to wild plants (Table 2). Using these pots required increased weeding (weeds grew out of the pot nipples). Better drainage and aeration meant these types of air-pruning pots also had noticeably higher water loss than smooth-walled pots. However, a key advantage was the ability to unwind the pot 'sheet' off a seed orchard plant without disturbing the numerous root tips. This improved survival when later planting seed orchard plants in the field. Repotting simply required wrapping a larger diameter 'sheet' around the bare rootball and filling the gap with fresh potting mix. This reduced plant stress and human effort, with no need to lift or move the seed orchard plants.

Figure 1. Bench height seed orchards are easier for maintaining, studying, assessing seed ripeness and collecting seed. Photo: David Willyams

Figure 2. *Chorizema ilicifolia* orchard plants produced more branchlets in Rocketpots® or Springrings®, leading to higher flower and seed production. Photo: David Willyams

Figure 3. *Banksia dallanneyi* seed orchards in Springring® pots; each plant individually watered, easily fertilised, weeded and kept in optimum condition. Photo: David Willyams

Figure 4. Cleaning *Banksia dallanneyi* seed-heads from orchards in pots is easier and more thorough than wild seed harvesting. Photo: David Willyams

Figure 5. *Banksia dallanneyi* seed orchards in pots produced good quantities of viable seed in 2007 whereas wild seed was in low supply due both to the record 2006 drought and heavy predation. Not using wild seed was a good conservation outcome. Photo: David Willyams

Figure 6. Testing the effect of shading, potting mix, pot type and size on *Ranunculus colonorum* seed production. Photo: David Willyams

We learnt that different plant forms required different growing containers and conditions, with some herbaceous species only requiring small pots for high seed production *e.g., Ranunculus colonorum* (Figure 6). With little known about *Ranunculus colonorum* biology we found that establishing a seed orchard in pots had additional benefits. The key pollinators, flowering and seed ripening times were identified (Figure 7). This phenology information assisted field biology studies and restoration monitoring. Each year this orchard produced more seed than was required for forest restoration, whereas in previous years little seed had been collected from the wild. It was also possible to collect seed at various stages of development to identify the optimum seed harvest condition. Yellow fleshy seed looked ideal but instead the seed needed to desiccate on the plant for optimum germination ability to develop. This was similar to the findings for *Clematis pubescens* (also in the Ranunculaceae).

Site and size considerations

An *Acacia saligna* seed orchard produced seed for 6 years but was then destroyed by a large regional wildfire in 2010. In hindsight the seed orchard was too close to the adjacent forest, with insufficient firebreaks. It also emphasized the need for critical seed orchards to be replicated and widely dispersed to avoid the complete loss of restoration seed supply following wildfires.

Estimating how many plants to have in seed orchards per species proved challenging. While it was desirable to have seed orchards of all species, early orchards indicated that certain species were high seed producers while others had low seed production (Figure 2). For restoration sites it was necessary to have background information on species mix, plant density and required seed production to determine how much seed of each species needed to be produced. For species in low densities in the forest then low seed production was not a negative. However, species with low seed production in the orchard were considered unsuitable for seed orchards being established at external agencies sites. Seed production orchards for such species are best retained onsite to facilitate further research and improvement.

Seed orchard partnerships

With increasing need for seed and nursery labour already stretched it was desirable to scale up seed orchard production with external partners. Several unsuccessful attempts were required before the first suitable partner was found. The most important element in developing effective partnerships was persistence. To ensure confidence and to justify the establishment costs, partner organisations needed to demonstrate they would be in the game for at least ten years, had security of land tenure, an adequate labour force and reliable water. Ideally, proposed seed orchards needed to be away from bushfire-affected areas or at multiple sites to

spread the risk. Having multiple partners was another way to achieve this. From the early landcare seed orchard outcomes it was understood that seed orchards and external partnerships do not last for ever. To ensure a regular supply of seed required continuous creation of new orchards and partnerships, while continuing to maintain and protect established orchards.

By the time the nursery closed, a large offsite seed orchard had been established at Karnet Prison Farm; with contracts in place for ongoing seed supply for Jarrah forest restoration. It was providing much of the seed from small nitrogen fixing legume species needed for restoration seed mixes (Willyams 2015). This orchard proved a reliable seed supplier, partly as the inmates could maintain plants and check for ripe seed every day of the year. A wonderful benefit was connecting the inmates with the surrounding Jarrah forest.

The key hands-on Jarrah forest understory species seed orchard work at Marrinup Nursery was done by Esther Noble, David Willyams, Greg Mullins, Robert Woodward and the Nursery Assistants; with Esther leading the establishment and success of the large Karnet Prison Farm seed orchard. The key progress drivers for all Marrinup Nursery seed orchards were the diverse team members working together with an enthusiasm to try new approaches, and the open investigation of failures for learning opportunities.

Figure 7. With the nursery and seed orchards surrounded by Jarrah forest it was possible to identify the major pollinators. In this example, native thrips on *Ranunculus colonorum*. Photo: David Willyams

Figure 8. Marrinup Nurseries largest 'seed orchard in pots' 2004. Photo: David Willyams

Table 1. Seed production 2003/4, Marrinup Nursery seed orchards

Species	grams
Acacia nervosa	12
Acacia saligna	7,230
Acacia wildenowiana	3
Banksia dallanneyi (*Dryandra lindleyana*)	113
Chorizema dicksonii	842
Chorizema illicifolium	276
Cyathochaete avenacea	42
Daveisia cordata	7
Daveisia physodes	92
Kennedia prostrata	117
TOTAL	**8,734**

References

Cromer, E. and Norman, M. (2006). Seed Management for Large-scale Land Restoration. *Australasian Plant Conservation: Journal of the Australian Network for Plant Conservation* 15 (1): 6-7.

Kabay, D. and Lewis, A. (1987). The collection, handling and storage of Australian native plant seed. In: Germination of Australian native plant seed, Australian Industry Research Association. Chapter 4, 124-146.

Mullins, G., Willyams, D. and Koch, J. (2004). Seed Orcharding at Alcoa's Marrinup Nursery. *Fifth Australian Workshop on Native Seed Biology for Revegetation*, Brisbane. Australian Centre for Minerals Extension and Research, Kenmore.

Willyams, D. (2015). How can plant propagation improve the environmental performance of an integrated bauxite and alumina operation? In: *Proceedings10th International Alumina Quality Workshop, AQW Inc., Perth*. Pp 411-420. (available online)

Willyams, D. (2016). Micropropagation of salt tolerant Eucalypts and Dieback Resistant Jarrah facilitated by nodal bud culture. *Acta Horticulturae* 1113: 119-126.

Table 2. *Banksia dallanneyi* seed production from in ground nursery orchards (Huntly and Willowdale) compared to forest populations. Forest plants had higher seed predation than managed seed orchard plants. Seed set per plant was much higher in the seed orchards than in the forest. All values are averages (+/- S.E.)

	Marrinup seed orchard (Huntly population)	Marrinup seed orchard (Willowdale population)	Unburnt forest (Huntly)	3 year old burnt forest (Huntly)
Seed per flower-head (ave)	9.5 (+/- 0.5)	5.7 (+/- 0.4)	1.8 (+/- 0.2)	0.9 (+/- 0.3)
Percent of seed predated (ave)	8.2	26.3	88.1	56.2
Flower-heads per plant (ave)	3.4 (+/- 0.5)	4.7 (+/- 0.9)	11.2 (+/- 2.5)	1.6 (+/- 0.9)

Case study: Successful clonal propagation and establishment of an offset subpopulation of the threatened plant

Pomaderris clivicola E.M.Ross (Rhamnaceae)

ALISON SHAPCOTT[1*], LUKE VERSTRATEN[1], KATIE ROBERTS[1], TRACEY MCMAHON[1], STEPHEN TRUEMAN[2], LEE HARPER[3] AND ISOBEL ALLEN[3]

[1]University Sunshine Coast; Genecology Research Centre; School of Science Technology and Engineering, Qld.
[2]Griffith University; Environmental Futures Research Institute, Qld.
[3]North Burnett Regional Council, Qld.
*Corresponding author: ashapcot@usc.edu.au

The species

Pomaderris clivicola E.M.Ross (Rhamnaceae) is only known from three locations in south-east Queensland, one on private land and two on road reserves. It is listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and endangered under the *Queensland Nature Conservation Act* 1992 (NC Act). It is a multi-stemmed shrub growing to 3–4 m tall. Flowering has been reported from December to March and in August, with fruits (capsules) subsequently in January to March and June. *Pomaderris clivicola* occurs in semi-evergreen vine thickets or tall open forests with vine thicket understorey on slopes or plateaux, in red volcanic soils (DEWHA 2008; DSEWPC 2012).

Threatening processes

A small population of 34 plants located on a road reserve on the Binjour Plateau was threatened by the need for road works to repair damage caused by landslips (Roberts and Trueman 2016). The main identified threats to the larger populations on private land are trampling by cattle, competition by introduced pasture grass (*Megathyrsus maximus*), increased fuel loads and changes to fire regimes (Thomas and Singh 1999; DEWHA 2008; DSEWPC 2012). There is a high potential for future landslips.

Deciding to translocate

The significant roadworks needed would directly impact four existing plants and ongoing road disturbance and future landslips were predicted to potentially threaten the remaining 30 plants in the road reserve. Thus, a program was instigated to translocate the four directly impacted plants and to propagate and establish a significant number of plants derived from the impacted population at a nearby suitable site of secure tenure to offset the current and anticipated impacts to the

Figure 1. Shoot collection at (left) the road reserve and (right) the offset site. Photos: Katie Roberts and Luke Verstraten

Figure 2. Cuttings (left) after setting in misting chamber and (right) with an emergent root. Photo: Luke Verstraten

wild population. An offset management plan was developed to aid and evaluate the establishment of the offset population.

Aim of the translocation

The translocation aimed to relocate plants directly impacted by the road works, propagate plants representing the genetic composition of the population at the impacted site, and establish an offset population to complement the remaining impacted population.

Translocation working group and key stakeholders

The project was overseen by North Burnett Regional Council who contracted the translocation of *P. clivicola* to Vegetation Matters and Ahern Contracting with on-ground management of the offset site to Ahern Contracting. Ongoing assessment of the adjacent SEVT (Semi-Evergreen Vine Thicket) and plants was undertaken by Wide Bay Environmental. Propagation was undertaken by the University of the Sunshine Coast. North Burnett Regional Council coordinated and conducted the final stages of the project using Council resources. Ongoing management, particularly fire management, of the State Forest which includes the subpopulation, will be conducted by Queensland Parks and Wildlife Service.

Biology and ecology

Whilst most translocations are undertaken using seed propagated plants, this is often not possible for many threatened species either due to low seed set, low genetic representation of the population or poor germination (Roberts and Trueman 2016). Direct translocation of adult plants is sometimes also undertaken but this is high risk due to potential establishment failure and is only possible for smaller-sized species (Dufourq and Shapcott 2019). Due to a combination of low seed set and poor germination success, in addition to the direct translocation of four adult plants, three *P. clivicola* plants were successfully clonally propagated for this project using field collected cuttings from the wild population to represent the genetic composition of the wild road reserve population (Roberts and Trueman 2016).

Multiple field collections of shoots were conducted over several years, 2013 to 2020. Planting at the offset site was also undertaken over successive years, in addition to the translocation of directly impacted adult plants, after plants had become established in a nursery (Roberts and Trueman 2016). The species proved challenging to propagate, using both tissue culture techniques and cuttings (Roberts and Trueman 2016). Despite a low rooting frequency (4.3%), the required number of plants was successfully propagated from shoots collected from both the wild population and the established offset population. Cuttings collected while populations were actively growing after rainfall led to a greater success rate and these plants were used to further supplement the offset population and provide stock plants for future harvests of cuttings. Collecting cuttings from nursery stock plants and field collected established propagated plants improved rooting frequency moderately, likely a result of improved plant nutrition and the reduced time between collection and setting.

Site selection

The offset site was selected with advice from Queensland Herbarium and Department of Environment and Science because of its proximity to the impacted population (15 km) and provides a similar climate and soil environment to that at the impacted population site. The site was also unlikely to be authorised for intentional disturbance, as it adjoined a SEVT population of an endangered species, *Fontainea fugax* (Euphorbiaceae), and other threatened plants. North Burnett Regional

Council negotiated and secured a land tenure arrangement with the Department of Environment and Science (DES; Qld Herbarium) to secure the site at Gurgeena which forms part of a State Forest.

Pre-translocation preparation, design, implementation and ongoing maintenance

The offset site was ripped to a depth of 600 mm with a dozer prior to planting to reduce root competition. Fire breaks were established and a weed management plan was incorporated into the ongoing maintenance schedule. Plants were set out around these fire breaks, mulched and watered regularly to assist in establishment. There was periodic monitoring of the plants including the use of a water meter to monitor soil moisture to determine if watering was needed. The North Burnett Region was drought declared in September 2019 which resulted in watering of the plants resuming to negate losses. There was some plant loss due to animal impacts and so the fencing of the site has been maintained. The final stage of planting took place in November 2020 and the site will be watered, as required and assessed by Council staff until the site returns to the management of Queensland Parks and Wildlife Service.

Outcomes

We have successfully now established over 300 plants of *P. clivicola* in various stages of growth at the offset site over several years. Thus, we now have a multi-aged size structure in the population. Plants have been regularly flowering on site and some seed has been produced but, to date, no naturally regenerated seedlings have been observed. Whilst the propagated plants were clonally derived, they were propagated from a diverse set of source material that completely represented the potential genetic variation found within the population being offset (Roberts and Trueman 2016). Given the few populations of the species, the propagated plants represent a significant increase in the total number of known plants. The plants established at the offset population are also less exposed to the major threats to the species.

What we learned

Clonal propagation can be employed to increase the total number of plants, better represent the genetic composition and establish new populations of endangered species for which propagation from seed is impracticable. Traditional methods used for propagating cuttings proved suitable for this species despite a lack of prior knowledge, and these were supplemented by tissue culture methods. Although rooting frequency was lower than rates normally acceptable for commercial propagation, it was adequate to achieve most of the required number of plants to establish the offset site. We recommend that clonal propagation be considered more widely as a potential method to conserve endangered plant species.

References and further reading

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). *Approved Conservation Advice for* Pomaderris clivicola. Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/55151-conservation-advice.pdf.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) (2012). *Pomaderris clivicola.* Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Dufourq, P. and Shapcott, A. (2019). The importance of fire in the success of a 15 hectare subtropical heathland translocation. *Australian Journal of Botany* 67: 531-545.

Roberts, K.S. and Trueman, S.J. (2016). Plant propagation for environmental offset planting: A case study of endangered *Pomaderris clivicola* and near threatened *Bertya pedicellata*. *Journal of Environmental Science and Technology* 9: 452-461.

Thomas, M.B. and Singh, S. (1999). *BRI file No. 900P, Field survey and report on the endangered species* Pomaderris clivicola. Queensland Herbarium, Environmental Protection Authority, Queensland.

Figure 3. ***Pomaderris clivicola*** **(left) with roots at mixed ages and (right) flowering. Photo: Luke Verstraten**

Figure 4. Planting and established plants *in situ* at Gurgeena Offset site. Photo: Isobel Allen

News from the Australian Seed Bank Partnership

Fire and smoke – Collecting, germinating and storing seed for Project Phoenix

DAMIAN WRIGLEY

National Coordinator, Australian Seed Bank Partnership.
Corresponding author: coordinator@seedpartnership.org.au

The Bushfires of 2019-2020 have been well documented for their impact on the Australian fauna and flora. Millions of dollars have been directed to supporting a wide range of recovery efforts across the southern and eastern states, supporting a vast number of organisations, species and ecological communities. Greening Australia's Project Phoenix was one such project to obtain financial support from the Australian Government to undertake a substantial body of work with an aim to *increase native seed and plant supply in preparation for the restoration of bushfire-affected areas and conservation of other valuable habitat.*

Project Phoenix could be considered a very ambitious project at the best of times, however, developing and delivering something of this magnitude following such wide ranging and intense bushfires, followed by the COVID-19 pandemic, is a significant challenge.

The Australian Seed Bank Partnership was engaged by Greening Australia to deliver various on-ground and long-term conservation actions for some of the priority species identified by the Australian Government's Bushfire Expert Panel. With support from the project team at Greening Australia, the Partnership worked closely with the Australian Government Department of Agriculture, Water and the Environment and Dr Rachel Gallagher from Macquarie University to ensure the project makes a meaningful contribution to the recovery and long term conservation of species impacted by the fires.

In addition to this, the Partners worked closely to refine a rapid assessment methodology developed in NSW by The Australian PlantBank that could be quickly and easily implemented by our collectors in the field. The printing of these specialised field books was supported by the UK Government's Foreign, Commonwealth and Development Office emergency funding for bushfires and will be used by our Partners over the coming seasons to monitor impact and recovery and inform future seed collection priorities.

With the size and focus of Project Phoenix, as well as four additional bushfire recovery projects, this season is proving to be busy throughout the country. And while many narrow range endemics and fire ephemerals are currently available for collection, the Partners are proceeding cautiously, ensuring they adhere to best practice collecting approaches, and in some cases avoiding collection where insufficient seed is available and the replenishment of the soil seed bank should be prioritised.

Target species for Project Phoenix in 2020/2021

National Seed Bank – Australian National Botanic Gardens

One notable species on our target list this year is *Dillwynia palustris*, one of the priority species identified by Gallagher *et al.* (2020) as requiring urgent intervention. *D. palustris* is a prostrate pea found in the Australian alpine region with grazing from feral herbivores a major threat. Following the 2003 fires we know that at least one of the five known populations regenerated after 12 months. This year's work will add important knowledge on the species ability to recover post-fire (McDougall and Walsh, 2007).

***Dillwynia palustra* occurs in only five locations including two on Mount Kosciusko. Photo: Murray Fagg, ANBG**

South Australian Seed Conservation Centre, Botanic Gardens and State Herbarium of South Australia

In January, I was fortunate that the COVID travel bans aligned perfectly to enable me to join Dan Duval, Jenny Guerin and Denzel Murfet on Kangaroo Island for collecting across multiple projects. The team at the South Australian Seed Conservation Centre had already undertaken trips to Kangaroo Island in late 2020 and engaged local practitioners and landowners in scouting specific species and bagging them for the January trip. One species in particular, *Chenopodium erosum*, was discovered on the south western part of the Island near Kelli Hill and Cape Bouguer, having not previously been recorded on the island. The chance discovery in 2020 led the team to revisit the site in early 2021, with significant numbers of individuals observed and a substantial conservation collection secured for secure storage *ex situ*.

Dan Duval, Denzel Murfet and Jenny Guerin taking a waypoint for a large population of *Chenopodium erosum* that was discovered near Cape Bouguer on Kangaroo Island. Photo: Damian Wrigley, ASBP

The impact on the island is significant with some vegetation communities showing good signs of recovery already. Some areas however continue to demonstrate slower rates of recovery, likely due to the severity of the fire in those areas. The team in South Australia are processing collections and have established seed orchards at the Adelaide Botanic Gardens to increase the seed available for long term *ex situ* conservation. More information on *Chenopodium erosum* as well as many others collected from Kangaroo Island this season are available online thanks to the support of many volunteers like Denzel Murfet who dedicate numerous hours of their time to uploading information and images online: http://www.syzygium.xyz/saplants/index_KI.html

Tasmanian Seed Conservation Centre, Royal Tasmanian Botanical Gardens

Other notable outcomes from the project will be collections of *Eucalyptus gunnii* ssp. *divaricata* from Tasmania, requiring arborists to undertake skilled collecting from the canopy, up to 15 metres high. Seed from these collections will further bolster the collections held at the Tasmanian Seed Conservation Centre at the Royal Tasmanian Botanical Gardens. Furthermore, these collections will be germinated at the centre with data made available through the TSCC's Germination Database, contributing to the germination information for the subspecies already available from collections made in 2015: https://gardens.rtbg.tas.gov.au/rtbgtsccgermdata/

Western Australian Seed Centre, Kensington, Department of Biodiversity, Conservation and Attractions

In Western Australia, the bushfires affected the Stirling Ranges National Park with many threatened species and declared rare flora known to be impacted by the fires. For those species where individuals survived adjacent to the fire scars, such as *Darwinia squarrosa* and *Xyris exilis,* collections are being made to bulk up previous, smaller collections, increasing the genetic diversity of seeds in *ex situ* conservation.

The Australian PlantBank, Australian Botanic Gardens, Mount Annan, Australian Institute of Botanical Science

With many places throughout New South Wales significantly impacted by the fires, collectors from the Australian PlantBank have been collecting from many areas. One site of great concern in the South East of the country is Mount Imlay (NSW) where the severity of the fires was significant. There are numerous species that occur nowhere else, with one in particular, *Boronia imlayensis*, known only from eucalypt woodland on a sandstone ridge of Mount Imlay. Rapid flora assessments are being conducted to better understand the species recovery process and to ensure we capture sufficient data to inform future seed collection activities post-fire.

Many of the collections on this year's list were selected due to the prioritisation undertaken by the Australian Government's Bushfire Expert Panel. The species collected and information gathered through rapid flora assessments will help to inform future plant prioritisation and bushfire responses. As we learn more about species recovery and the emerging threats and challenges to recovery, the Partnership will be able to further refine target lists for the second and third year's collecting post-bushfire. We hope that this process will help ensure our efforts in identifying and prioritising those species that are in most need of *ex situ* conservation measures will support the future integrity of populations *in situ*.

Boronia imlayensis **as captured by Gavin Phillips on a sandstone ridge on Mount Imlay in 2016. The many shades of flower of this rare native species illustrates the genetic diversity that can occur over small areas. Photo: Gavin Phillips, RBGDT**

Victoria Conservation Seedbank, Royal Botanic Gardens Victoria

While a good number of species from the Australian Government priority list are being targeted this year, there is also a number of regionally significant species the Partnership is targeting. Following extensive exploration of priorities with state and territory environment agencies, the Partners have identified many species that fall within the fire scar, or have distributions significantly close to the fire scar, to mean the impacts of post-fire threats such as disease and predation present an increased risk to their persistence *in situ*. One such species is *Ozothamnus adnatus,* a species considered vulnerable in Victoria, occurring in just three isolated populations, with only one population previously stored in conservation seed banks. Efforts to collect the species under Project Phoenix aim to ensure greater genetic diversity can be conserved.

Emerging from the fires with a stronger seed sector

At the coordination level, it is inspiring to be involved in the discussions of the External Steering Committee for Project Phoenix and contribute to the conversation at the national level. This rare opportunity to have substantial funding to support the seed sector to prepare for future bushfire and major disturbance scenarios means that we are closer to achieving a viable and sustainable seed sector across both longer-term conservation seed banking and shorter-term restoration seed banking. The complementarity of our collective efforts and this renewed focus on the future contribution of seed knowledge, collection, storage and use, to support the conservation of Australia's native plants, will hopefully see continual improvement in our capacity to understand, manage and respond to bushfires.

References

Gallagher, R. (2020). *Interim National Prioritisation of Australian Plants Affected by the 2019-2020 Bushfire Season*. Version 1.3. Macquarie University. PP. 1-55. Availability: http://www.environment.gov.au/system/files/pages/289205b6-83c5-480c-9a7d-3fdf3cde2f68/files/interim-report-plants-requiring-urgent-management-intervention.pdf. [Accessed on 12 June 2020].

McDougall, K. and Walsh, N. (2007). Treeless vegetation of the Australian Alps. *Cunninghamia* 10(1):1-57.

ANPC member profile

Luke Sweedman

What is your current position?

Curator of the Western Australian Seed Centre, Kings Park.

What projects are you working on at the moment?

I have just completed a 61-day field season collecting seed from species that may be susceptible to Myrtle Rust. The areas we considered the most likely to have affected species are from Shark Bay in the north down to Israelite Bay in the far south east of the state and everything in between. We compared our existing Myrtaceous seed bank species with those we did not have in the collection to prioritise the collecting.

How did you end up working in plant conservation?

The job I have is the plant collecting role supporting the State Botanic Gardens, a position held since 1963 (I am the third collector since then). The gardens only display the WA flora, and we need wild collections to support this. I collect seed and cutting material. From just a plant collection role it has evolved into a plant conservation role and the Seed Centre is now a state of the art facility operating to international standards. As a collector I have contributed the second largest number of species to the Millennium Seedbank Project in the world, something I am very proud of. The largest number is 2,683 and I have contributed over 2,000 wild plant species. These are all duplicated collections at Kings Park. I have held the position for 31 years.

What is your favourite plant and why?

I would have to say *Eucalyptus sweedmaniana* which I co-discovered and was named after me. I also love Banksias with a passion especially *Banksia menziesii* and *burdettii* which I showcase in my home garden.

Luke Sweedman at Cape Arid with *Eucalyptus sweedmaniana*. Photo: Chelsea Payne

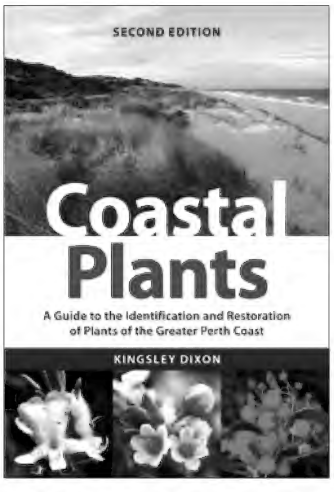
Why do you think the ANPC network is important and what do you see as our priorities?

The ANPC network has played a significant role in maintaining seed conservation standards for the collection and storage of germplasm. The priorities are to continue to maintain the protocols for conservation and tell the story of the many amazing people and plants that we are all working with. Maintaining a profile with government would also keep pressure on for more sustainable land management policies for our existing, but fast disappearing, precious, wild flora.

Book reviews

Coastal Plants

Paperback | May 2020 | $ 44.99 | ISBN: 9781486311378 | 356 pages | 215 x 148 mm
Publisher: CSIRO Publishing | Colour photographs, Illustrations, Maps



Western Australia has over 10,000 km of coastline. This extensive area covers a range of climates and houses a variety of fascinating ecosystems. While 80% of Western Australians live within 80 km of the coastline, the area that is most densely populated is the area around the State Capital, Perth. The plants of this region are featured in the recently published second edition of the book *Coastal Plants: A Guide to the Identification and Restoration of Plants in the Greater Perth Coast*. Author Kingsley Dixon, a long-time member of an urban coastcare group, Cambridge Coastcare, provides comprehensive information on these interesting plants, as well as approaches for their management.

The book commences with a section on ecology and biology, which highlights the biodiversity and endemism in the region. The plants in the region have been affected by urban development, and this is covered in a discussion on conservation planning. An interesting description of the geomorphology of the dune systems which make up the coastline follows, and the processes of erosion, deposition and plant colonisation and dune stabilisation. Plant adaptations to this salty, windy and fire prone environment are outlined.

Ecological restoration is the focus of the second section, and describes a paradigm shift in management away from simply sand stabilisation towards biodiversity conservation. This section draws heavily on the National Standards for the Practice of Ecological Restoration in Australia (Standards Reference Group, 2017), and shows the application of the recovery wheel, a tool used to assess restoration. The how-to guide for planning, defining a reference system, propagating, planting, monitoring and evaluation, steps through the restoration process. Specific techniques for coastal environments, such as erosion stabilisation, sand-capture fencing, and plant protection are illustrated.

The largest part of the book is the species guide, which contains descriptions of 128 species from the region. Each species has a full page of text describing the flowering period, morphology, pollination, distribution, propagation, and use in restoration. On the facing page, several colour photographs show off the species' habit, with close ups of the flowers, fruit, and/or leaves, as well as a distribution map. The species guide is arranged alphabetically by genus, and includes the family name and common name. Non-native species are also included at the end of the section, with a description of their control methods.

A valuable addition to the toolkit of all coastcare volunteers in the Perth region, this book will also be of use to environmental managers in local government areas along the coast. The species guide will be helpful to members of wildflower societies, photographers and travellers to assist with plant identification. Those conserving and restoring coastal areas in other parts of Australia may learn from some of the generic techniques and the process of how to plan, implement and monitor coastal restoration.

Lucy E. Commander

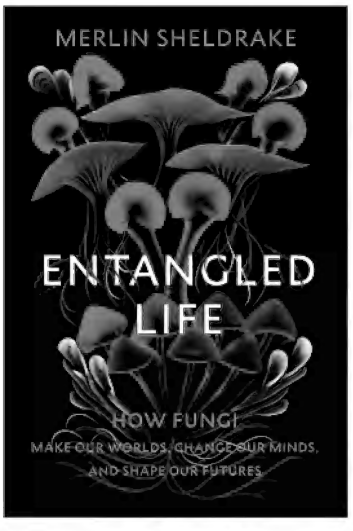
Australian Network for Plant Conservation
The University of Western Australia

Reference

Standards Reference Group (2017). *National standards for the practice of ecological restoration in Australia*. 2nd edn. Society for Ecological Restoration Australasia.

Entangled Life – how fungi make our worlds, change our minds, and shape our futures

Merlin Sheldrake | 2020, The Bodley Head, London.368 pp.
Paperback ISBN: 9781847925206, rrp AU$35.00 | Hardback ISBN: 9781847925190, rrp AU$39.99 | EBook: ISBN: 9781473554689
Audiobook download: ISBN: 9781473580824, rrp AU$24.99



The fundamental role of soil and litter biota, and specifically fungi, has been a rising theme in ecological writing and research for the last three decades, although it is still crippled, in Australia and globally, by a drastic shortfall in investment, institutional attention, and professional training and employment.

Still, most people concerned with plants or land management have some knowledge of plant/mycorrhiza associations, the importance of soil health for water and nutrient capture and retention, and maybe even the untapped biological resources of the fungal kingdom. Sheldrake argues that the accumulating pile of startling new findings about what fungi are capable of means that we should prepare ourselves for a conceptual upgrade regarding these largely microscopic systems: "These organisms [fungi] make questions of our categories and thinking about them makes the world look different".

Fungi, collectively, are more capable of fine-slicing the exploitable resource-space than a bastardry (the collective noun) of telecommunication companies, although Sheldrake warns against simplistic assumptions about who is exploiting who in the soil biosphere. He identifies two particular "fast-growing fields of biological enquiry" that he finds central to the fungal world. The first is the "problem-solving behaviours that have evolved in brainless organisms", exemplified by the well-established patterns of learning by 'individual' organisms among the slime moulds, but increasingly recognised on a wider basis. The second is "the way we think about microbes" and the individuality of organisms.

Sheldrake's initial focus is on mycorrhizal fungi, the ones that associate with plant roots and have a complex role in nutrient and water exchanges. But the interface between mycorrhiza and plant can be deep within the plant, and this leads to a discussion of fully internalised micro-biota and the meaning of the 'individuality' of organisms. Sheldrake has a liking for lichens as a model for mutualism, and an example of how the more we look the more we find. Noting the newly recognised role of secondary fungal species and bacteria in lichen formation, he comments "But now a duet [of fungus and alga] has become a trio, the trio has become a quartet, and the quartet sounds more like a choir".

The microbial 'load' inside humans and other multicellular organisms has long been known, but we have been slow on the uptake. We are used to thinking about certain mutualisms – corals, lichens, and plant/mycorrhiza associations – but usually only in terms of biologically distinct partners, and usually only two of those – only one couple on the dancefloor. It is now increasingly clear that many such associations are a mosh-pit involving multiple partners, and not just fungi but bacteria and other greeblies – every individual plant and animal is an ecosystem in its own right in some respects. The 'individual' is a holobiont. It will be a project for the coming decades finding out what this means for our concepts of biosecurity, plant and animal health, pest and disease management, and best practice in conservation, propagation, and translocation.

Sheldrake warns us in his Introduction that the deep dive into micro-ecological complexity can be very disorienting, and requires conceptual change. He does not discount the value of metaphor, human analogy, and imagination in thinking ourselves into a more complex reality, most of it beyond our direct senses, but he wisely recommends keeping these on a fairly short leash.

Reductio ad absurdum being a common human failing, it is of course possible, once you start to question the meaning of the individuality of organisms, to disappear down a rabbit-hole of either reductionism or uncertainty. We see the former a lot from the more reductionist schools in genetics – or at least their popularisers – for some of whom organisms are no more than vehicles for a determinist bundle of molecules, or an even more abstract idealist notion of 'information' realising itself. At a certain level it's an insight, but taken as a world-view it is dangerously silly, because it abandons any sense of different concepts being necessary at different scales of reality. Another trend surfaces from time to time in ecology, with elaborate arguments advanced that the compositional and historical plasticity of biotic systems renders void any meaningful notion of definable ecosystems or ecological communities. Again, it depends on what you are describing, the spatial and temporal scales you are using, and the degree of complexity you are trying to portray.

A horse is a horse, of course, of course, and not just a vehicle for a complex bacterial endobiome, at least not if you are interested in horse-racing.

Sheldrake for the most part avoids both the conceptual rabbit-holes and the woolly romanticism of some recent popular writers on the microbial and fungal worlds. He keeps an admirable check on the tendency to universalise. He has clarity of expression, and a presentational logic that does not often ignore inconvenient facts or counter-arguments, and avoids the trope of letting a preconceived answer dictate the question, just to make a good story. He avoids the temptation to portray every new insight as overturning Darwin and the scientific establishment. Above all, he respects the past accumulation of human knowledge, scientific or not, and the iterative, incremental, and imaginative elements of the knowledge-generation process.

The book is all about the role of fungi in connectedness and interchange, especially in soil. Levels of connectedness between organisms that he describes include horizontal gene transfer (in bacteria, fungi, and by viral vector in other kingdoms); serial endosymbiosis (the acquisition of bacterial-origin mitochondria and chloroplasts was fundamental for most complex life); and bilateral and multilateral mutualisms (from simple mycorrhizal relationships, through lichens and corals as flexible associations, multi-species 'wood-wide web' connections, although he dislikes the term). "Life is nested biomes all the way down", says Sheldrake, "Where does this leave you? Or perhaps y'all?". It's a good question.

There are some weaknesses. Non-mycorrhizal fungal endophytes (*i.e.,* those living in the non-root tissues of plants) get only a passing mention. There is perhaps a little too much space devoted to the author's personal interest in psychedelics and home-brew – although others will see these interludes as adding to the general readership appeal of the book. The weakest chapter is 'Radical Mycology', which starts out well with an overview of the world-changing advent of lignin-decomposing fungi (no more coal formation!), and then seems to promise an examination of how mycologists are making progress despite the lack of resourcing for the discipline – but then delivers only sketches of a handful of advocates and fungal-product entrepreneurs, all of them North American. Doesn't matter.

Our growing recognition of the wider realms of biotic complexity is partly a conceptual issue – moving ourselves up from simplex thinking – and Sheldrake stresses this. It is also partly a reflection of our historically and biologically limited sensorium, an aspect that he does not address systematically. In reducing our anthropocentric conceptual approach to the living planet, it might be worth considering in an integrated way how our sensorium has been augmented from the five senses of sight, touch, smell, taste and hearing – the only available bases for empirical knowledge generation through most of our species' history – by enormous progress in microscopy (optical and electronic), biochemical analysis tools (starting with spectrometry, spectroscopy, and chromatography), and visualisation tools (notably fibre optics). These are culminating in a vastly improved ability to view life processes *in situ* and *in vivo*, which is to say at least partly on the observed organism's own terms. Examples include capillary electrophoresis for DNA differentiation, liquid-phase electron microscopy for observing certain live processes, and perhaps above all proteomics and metabolomics to track the processes at intra- and inter-cellular levels, sometimes in real-time, a core requirement for understanding the kind of interactions that Sheldrake describes. This expanded sensorium demands new descriptive vocabularies and will inevitably shake our concepts of relationships and process. Judging by this book, Sheldrake might be the person to produce an accessible work on this.

Entangled Life should be on the required reading lists (if they still exist?) of all biology and environmental science 101 courses. It would fit very well into any late-secondary or tertiary curricula based on the Big History approach. And it makes an excellent present, which is how I got mine – thanks Bracksie!

Bob Makinson
Bobmakinson2073@gmail.com

POSTSCRIPT – some Australian fungal foci:

- *FungiMap* (https://fungimap.org.au/) is an incorporated association with national scope, lots of on-line and printed resources, identification images for a range of macrofungi, and a monthly newsletter.
- *The Australasian Mycological Society* (https://www.australasianmycologicalsociety.com/) works to promote research and teaching in all areas of fungal biology, to raise the profile of mycology in the Australasian region, to promote the conservation of Australasian fungi and to facilitate networking and collaboration among mycologists. In Covid conditions they have initiated a virtual seminar series and also provide links to eTalks and eMeetings by various universities and societies.
- *Fun Fungi Ecology* (https://funfungiecology.com/) has a range of links and resources and a 'Fungi for Land' project under development.

News and conferences

ANPC News

ANPC president presented at threatened plant webinar

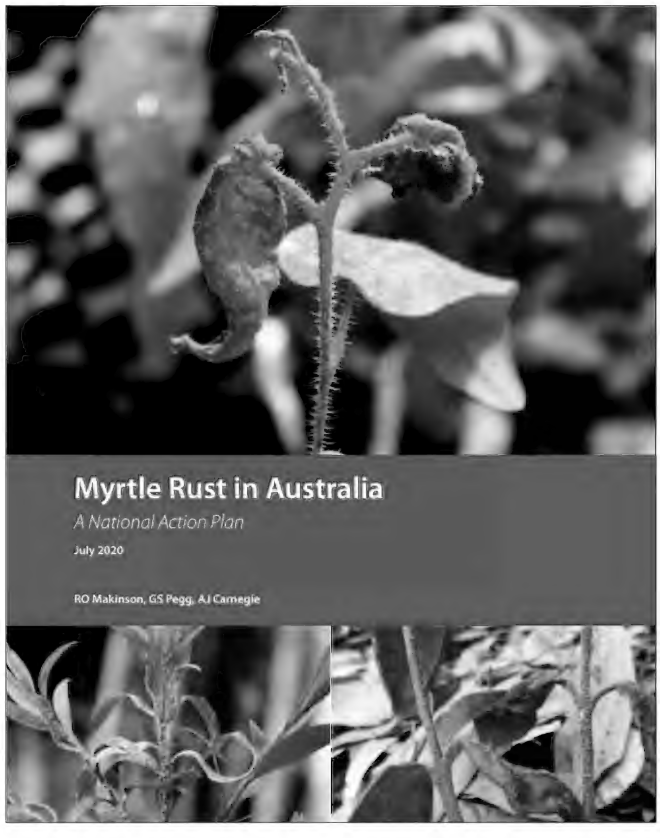
On 8 December the NESP Threatened Species Recovery Hub held a free webinar titled 'Halting the decline: efforts to track & save Australia's threatened plants.' The webinar was held to launch the threatened plant index. Dr Tony Auld gave a ten minute presentation on the importance of our threatened plants and issues raised by the index. The entire webinar can be viewed at **https://www.nespthreatenedspecies.edu.au/events/threatened-plant-index-webinar-special**

Myrtle Rust in Australia – a National Action Plan

The plant disease Myrtle Rust was detected in Australia in 2010. It has been found capable of infecting 382 native species including paperbarks, tea-trees and eucalypts. Myrtle Rust is listed under the EPBC Act as a key threatening process. Yet there was no nationally coordinated response strategy for this threat. The ANPC's committee member Bob Makinson helped prepare the Myrtle Rust National Action Plan which provides the foundation for a coordinated national response to this disease. The plan proposes two overarching recommendations and highlights priority actions for the next 3-5 years. Read the Plan at **https://www.anpc.asn.au/wp-content/uploads/2020/11/Myrtle-Rust-National-Action-Plan-2020.pdf** or head to our website for more information on Myrtle Rust including a 1 page summary of the ANPC's work on this issue **https://www.anpc.asn.au/wp-content/uploads/2020/11/ANPC-Myrtle-Rust-response-2010-20.pdf.**

Healthy Seeds Project

The Healthy Seeds Project, funded by the NSW Environment Trust, is nearing completion. The Healthy Seeds Draft Roadmap was made available to the Healthy Seeds Consortium meeting in early December with the current Draft FloraBank Guidelines. The Roadmap provides a summary of the elements of the Healthy Seeds project, the findings of assessments on the status of the native seed sector in NSW, the issues and concerns raised in the process and the suggested direction and pathways to address these issues over time. There are now 14 FloraBank modules back from review. All drafts will be available soon for review, consultation and feedback. Project managers, Martin Driver and Lucy Commander would like to give their continued thanks to



Acacia seed pod. Photo: Lucy Commander

all the authors, reviewers and other contributors to date. Martin and Lucy have also been assisting with Greening Australia's Project Phoenix. The process for dissemination, consultation and alignment of the Healthy Seeds project with with the Project Phoenix is in development subject to COVID status conditions and safety guidelines.

Contact Martin and Lucy if you are interested in discussing the Healthy Seeds project.
https://www.anpc.asn.au/healthy-seeds/
https://www.anpc.asn.au/florabank/

Fire and Rust

Numerous sites and ecological communities in Queensland and New South Wales have been surveyed to determine the susceptibility and impact of myrtle rust on Myrtaceae species regenerating after the 2019-20 bushfires. Funding from the NESP Threatened Species Recovery Hub has been extended for the project which means a second round of assessments can be conducted at each site. Researcher Dr Geoff Pegg, forest pathologist for the Queensland Department of Agriculture and Fisheries, gave a presentation about the project as part of the 2020 environmental biosecurity webinar series. Watch the recording of the Myrtle rust webinar here **https://haveyoursay.awe.gov.au/2020-environmental-biosecurity-webinars/widgets/307583/key_links** Geoff also recently introduced the Fire and Rust project in a webinar. View the recording (**https://www.youtube.com/watch?v=JMk7ugfC5lI**) to learn how the project aims to determine the impact of myrtle rust on native plants in NSW and south east Queensland. To learn more about the project head to the ANPC webpage **https://www.anpc.asn.au/fire-and-rust/**

Germplasm Guidelines Review

We are excited to share a series of case studies from the Germplasm Guidelines currently being updated by the ANPC. These case studies capture the challenges of *ex situ* native plant conservation, and can be found at **https://www.anpc.asn.au/germplasm-guidelines-review/ex-situ-conservation-case-studies/**.
The Germplasm Guidelines are now in the review process. If you would like to review part of the guidelines prior to publication, please email the project manager Amelia Martyn Yenson at amelia.yenson@bgcp.nsw.gov.au

Preventing extinction in bushfire affected orchids – project update

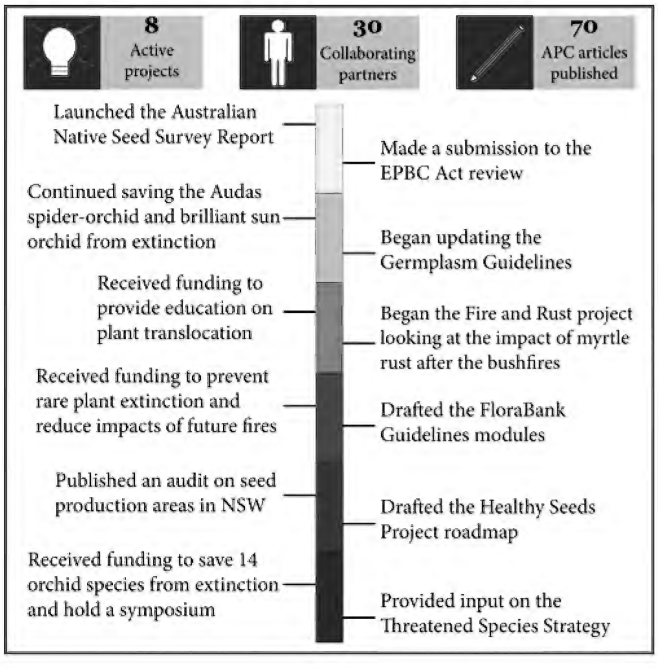
Post-fire survival surveys have been completed for 13 of the 14 target orchid species, with surveys for the final species to be undertaken in the first week of February. Collections of seed have been undertaken for 11 of the 14 target orchid species, with the remainder to be conducted during January-March. Mycorrhizal fungi collections have been made for all but one of the 14 orchid species and studies on reproductive biology are underway.

Orchid Conservation Symposium – 22-23 June 2021

The Australian Network for Plant Conservation Inc., in collaboration with La Trobe University, the Royal Botanic Gardens Victoria and the Botanic Gardens of South Australia, is holding a free online orchid conservation symposium on Tuesday 22nd and Wednesday 23rd June 2021. For more information on the project and to subscribe to the symposium mailing list visit **https://www.anpc.asn.au/projects/preventing-extinction-in-bushfire-affected-orchids/**

***Caladenia ancylosa*. Photo: Ryan Phillips**

2020 Highlights



Fenner Conference on the Environment—'Exceptional times, exceptional plants'

This conference will focus on *ex situ* conservation strategies for Australian plants that cannot be conserved by conventional seed banking methods. The conference will provide an opportunity for scientists working on the conservation of Australia's diverse flora to evaluate methods for conserving plant germplasm (seeds, plants and other plant tissues), adding value to guidelines produced by the Australian Network for Plant Conservation.
https://www.science.org.au/news-and-events/news-and-media-releases/conferences-explore-dynamics-southern-ocean-and-conservation

Plant cuttings

Editors' note: News excerpts are clipped from a diversity of sources. To read the articles in full follow the links attached to each clipping. The views expressed in these articles are those of their authors and do not necessarily represent the opinion of the ANPC.

Prioritizing where to restore Earth's ecosystems

Targets for ecosystem restoration are usually specified in terms of the total area to be restored. A global analysis reveals that the benefits and costs of achieving such targets depend greatly on where this restoration occurs.
https://www.nature.com/articles/d41586-020-02750-2

To save threatened plants and animals, restore habitat on farms, ranches and other working lands

Restoring native habitats to at least 20% of the world's land currently being used by humans for farming, ranching and forestry is necessary to protect biodiversity and slow species loss, according to a newly published study conducted by a team of environmental scientists including us. Our analysis found that this can be done in ways that minimize trade-offs and could even make farms more productive by helping to control pests, enhancing crop pollination and preventing losses of nutrients and water from soil.
https://theconversation.com/to-save-threatened-plants-and-animals-restore-habitat-on-farms-ranches-and-other-working-lands-148523

Supporting Indigenous Research

The Morrison Government is funding university research to improve the lives of Indigenous Australians while providing leadership and training opportunities to Indigenous researchers. Minister for Education Dan Tehan announced $7.1 million for nine new research projects through the Australian Research Council (ARC) *Discovery Indigenous* scheme.
https://www.arc.gov.au/news-publications/media/media-releases/supporting-indigenous-research

Citizen Orchid

Orchids are one of the largest plant families on earth with thousands of species, and Australia has some of the rarest ones. Sophie meets orchid expert's Dr Robert and Rosalie Lawrence for a careful walk to find some orchids in remnant bushland outside of Adelaide.
https://www.abc.net.au/gardening/citizen-orchid/12848698

Monitoring ecosystems after intense fires

The fires in eastern Australia over the summer of 2019 and 2020 were widespread and severe. So how have ecosystems been affected? Peter Hadfield joined ecologists and locals with knowledge of flora and fauna inspecting forests recently burnt by fire. As ecologist Chris Dickman explains, while Australian species are adapted to fire, the intensity of recent fires will likely lead to permanent changes in ecosystems and could even lead to collapse with eucalypt forests replaced by other ecosystem types.
https://www.abc.net.au/radionational/programs/scienceshow/monitoring-ecosystems-after-intense-fires/12855816

Australian researchers find native grasses could be grown for mass consumption

Native grasses could be grown for mass consumption, a one-year feasibility study has found, after researchers tested 15 different species "from paddock to plate" in north-west New South Wales. **https://www.theguardian.com/australia-news/2020/nov/10/australian-researchers-find-native-grasses-could-be-grown-for-human-consumption**

Captain Cook used a native Australian plant to fight scurvy. Are Indigenous foods the future?

Juru and Kanaka man Gerald Power often hears from people that food eaten by First Nations people in the tens of thousands of years before colonisation did not have much seasoning. It is a myth he is keen to correct. Mr Power cultivates many edible native plants, including bush basil, curry myrtle and river mint, in a community garden in Orange, in central-western NSW. **https://www.abc.net.au/news/2020-11-12/australian-food-indigenous-herbs-school-cooking-programs/12860554**

Tree collecting is becoming a conservation mission with plenty eager to sign up

Of all the things you might amass, trees would have to be one of the most unwieldy. They take up space and they soak up time. It's not a pursuit for the restless.
https://www.smh.com.au/lifestyle/health-and-wellness/tree-collecting-is-becoming-a-conservation-mission-with-plenty-eager-to-sign-up-20201106-p56c62.html

Future Forests

In this snippet from episode 36 (series 31) of Gardening Australia Josh explores how an Urban Forest Strategy developed by community volunteers is successfully bringing nature into the city. If you look closely you will catch FloraBank project manager Dr Lucy Commander planting seedlings in the background.
https://www.abc.net.au/gardening/factsheets/future-forests/12904494?fbclid=IwAR1pMzpl-GKR_76d6UCpBPZZhjBPJ0hrEbTK2JD4zZA-qonpISYts3H5Tfc

Argyle diamond mine's traditional owners turn to native seeds in bid to restore country

The closure and rehabilitation of Australia's most famous diamond mine is being seen as an opportunity for traditional owners to reconnect with country and grow an exciting new business venture in the remote East Kimberley.
https://www.abc.net.au/news/rural/2020-11-21/argyle-mine-transitioning-from-pink-diamonds-to-native-seed/12902012?fbclid=IwAR1kEsn6hWf6Qemp7W6tWGV9ZqCjytFXziTOdyN4fbGqeYqMK1MZY2tOpmk

Make your garden a haven for native pollinators to help the bush regenerate

Pollination is a crucial part of revitalising natural bushland following the Black Summer bushfires, and many of Australia's native plants rely on pollinating insects. Eurobodalla Shire Council is offering residents bush-friendly garden visits to help them make the best choices for native plants for pollinators.
https://aboutregional.com.au/make-your-garden-a-haven-for-native-pollinators-to-help-the-bush-regenerate/

Burdekin ecosystem program to better protect the Great Barrier Reef

Coastal ecosystems in North Queensland will be better protected under a new three-year program to be delivered in the Burdekin region. NQ Dry Tropics will work with community partners to improve the health of native vegetation, fish and other animals in a bid to improve the health and resilience of the Great Barrier Reef.
https://www.queenslandcountrylife.com.au/story/7040513/coastal-ecosystems-protected/?cs=4698

Eleven hectares of land leased to university for conservation plant-out

Eleven hectares of land in Wellington's Outer Green Belt has been handed over to a university project to plant native forest. The University expects somewhere between 18,000 and 28,000 trees could be planted on the site.
https://www.rnz.co.nz/news/national/432025/eleven-hectares-of-land-leased-to-university-for-conservation-plant-out

Myrtle Rust Update: Mature Native Trees Now Dying

The first known case of mature tree death due to myrtle rust infection has been observed in the East Cape of Aotearoa New Zealand, suggesting localized extinction for some native myrtles could become a reality.
https://www.scoop.co.nz/stories/AK2012/S00209/myrtle-rust-update-mature-native-trees-now-dying.htm

Human-made materials now outweigh all plants and animals on Earth, says new

The year 2020 marks the first time human-made materials have outweighed biomatter such as plants and animals, according to new research. The mass of the world's roads, buildings, machines and other human-made items has doubled every 20 years for the past century, the team of Israeli scientists found.
https://www.9news.com.au/national/human-made-materials-outweigh-biomass-like-plants-animals-for-first-time-in-2020/94e8f96e-c396-42f3-857f-51c62e31990a

Addition to list of threatened ecological communities

On Tuesday December 15th the Minister for the Environment, the Hon. Sussan Ley MP included the 'River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria' on the list of threatened ecological communities (TECs) under the *Environment Protection and Biodiversity Conservation Act 1999*.
http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=154

Australia-first research reveals staggering loss of threatened plants over 20 years

New Australia-first research shows the population sizes of our threatened plants fell by almost three-quarters, on average, between 1995 and 2017. The findings were drawn from Australia's 2020 Threatened Species Index, which combines data from almost 600 sites.
https://theconversation.com/australia-first-research-reveals-staggering-loss-of-threatened-plants-over-20-years-151408

'Ugliest orchid in the world' among 2020's new plant discoveries

The "ugliest orchid in the world", a toadstool discovered at Heathrow airport, and a bizarre scaly shrub have topped a list of new species named by scientists at the Royal Botanic Gardens at Kew and their collaborators in 2020.
https://www.theguardian.com/environment/2020/dec/17/ugliest-orchid-in-the-world-among-2020s-new-plant-discoveries-kew-gardens

Weeds at the Early Stage of Invasion Project wins Froggatt award

A project that gives land managers the tools to eradicate new weed invasions before the weeds get a stranglehold in sensitive bushland, coastal and alpine environments has won one of this year's national Froggatt awards.
https://invasives.org.au/media-releases/victorian-project-tackling-high-risk-invasive-weeds-wins-national-froggatt-award/

Rising from the ashes - Kangaroo Island's rare and endemic flora

Teams of volunteers led by botanists, including local Michelle Haby, have been surveying the bushfire-ravaged western end of Kangaroo Island for rare and threatened plant species. Results so far have been promising, with seedlings or suckers of all of the 17 target plant species already observed within burnt areas.
https://www.theislanderonline.com.au/story/7061358/rising-from-the-ashes-kangaroo-islands-rare-and-endemic-flora/

The mystery of the blue flower: nature's rare colour owes its existence to bee vision

At a dinner party, or in the schoolyard, the question of favourite colour frequently results in an answer of "blue". Why is it that humans are so fond of blue? And why does it seem to be so rare in the world of plants and animals? We studied these questions and concluded blue pigment is rare at least in part because it's often difficult for plants to produce.
https://theconversation.com/the-mystery-of-the-blue-flower-natures-rare-colour-owes-its-existence-to-bee-vision-153646

Rare plant from the Manning increases in population following bushfires

A rare plant found only in the Manning Valley has awed researchers, after its population increased from just 600 to more than 20,000 plants following the 2019-20 bushfires.
https://www.greatlakesadvocate.com.au/story/7067637/rare-plant-from-the-manning-increases-in-population-following-bushfires/

'Like finding life on Mars': why the underground orchid is Australia's strangest, most mysterious flower

If you ask someone to imagine an orchid, chances are pots of moth orchids lined up for sale in a hardware store will spring to mind, with their thick shiny leaves and vibrant petals. What about a small, pale tuber that spends its whole life underground, blooms underground and smells like vanilla? This is the underground orchid, *Rhizanthella*, and it's perhaps the strangest Australian orchid of them.
https://theconversation.com/like-finding-life-on-mars-why-the-underground-orchid-is-australias-strangest-most-mysterious-flower-144727

Striking Christmas bell wildflowers bloom in abundance after bushfires, then rain at Port Macquarie

Striking red and yellow Christmas bell flowers are blooming in abundance in northern New South Wales, creating an eye-catching display among coastal heathland. The native wildflowers have emerged in huge numbers this summer in the wake of high rainfall and previous bushfires.
https://www.abc.net.au/news/2020-12-31/striking-christmas-bells-bloom-in-abundance-bringing-joy/13022108

Wollemi pines given special protected status after being saved from bushfire disaster

The world's only known natural stand of Wollemi pines has become the first site in New South Wales to be given special protected status to try to ensure its survival for future generations.
https://www.theguardian.com/environment/2021/jan/15/nsw-wollemi-pines-given-special-protected-status-after-being-saved-from-bushfire-disaster

Rare pink flannel flowers bloom after bushfires

On a stony, bushfire-ravaged slope overlooking a Blue Mountains valley near Katoomba, NSW, ultra-rare pink flannel flowers bloom in their thousands, bringing new life and colour to landscape still charred by the fiery summer of 2019/20.
https://www.australiangeographic.com.au/news/2021/01/rare-pink-flannel-flowers-bloom-after-bushfires/?utm_source=website_cta&utm_medium=post_directory&utm_campaign=on_site_links

Forests fight back after bushfire infernos

About 70 per cent of plant species in Australia's eucalypt forests will survive bushfires through defence mechanisms developed over millions of years.
Five scientists from Griffith University and the Australian National University conducted an expert review of scientific research around forest fire recovery.
https://www.australiangeographic.com.au/news/2021/01/forests-fight-back-after-bushfire-infernos/

Covid-19: Dartmoor lockdown crowds 'destroying' ancient woods

An influx of lockdown visitors taking exercise on Dartmoor has raised concerns about an ancient woodland. Devon county councillor Philip Sanders said people had been camping, making fires and stripping moss from the trees at Wistman's Wood.
https://www.bbc.com/news/uk-england-devon-55808392

Events and opportunities

Managing weeds after fire – SWIFFT webinar series

SWIFFT (State Wide Integrated Flora and Fauna Teams) produced a four part webinar series at the end of 2020. A series is titled 'Weed management after fire' and focuses on sharing practical knowledge so everyone can contribute to bushfire recovery. To watch the webinar recordings visit the website. **https://www.swifft.net.au/cb_pages/weed_management_after_fire_-_webinar_series.php**

Orchid Mini Symposium – Australian National Herbarium

A free, online orchid mini symposium was held on Tuesday 2nd February 2021. Organised by the Australian National Herbarium to honour the distinguished career of Dr Mark Clements the theme of the event was 'advances in Australian orchid research'. To watch the symposium head to **https://webcast.csiro.au/#/webcasts/markclementssymposium**

TEDx talk recording – The other pandemic: Can we save our native plants from extinction?

In this talk, Dr Karen Sommerville, Research Scientist at the Australian Institute of Botanical Science introduces us to seed banking, one tool we can use to protect our precious plants, and our future – provided we act quickly. Watch the recording: **https://tedxsydney.com/talk/the-other-pandemic-can-we-save-our-native-plants-from-extinction-karen-sommerville/**

Australasian Seed Science Conference – Canberra ACT, 5-9 September 2021

As a result of the impact of the COVID-19 virus, the Australasian Seed Science Conference will be held online in September 2021. Both early bird registration and abstract submission are open. For more information please visit the Conference website and join the mailing list to stay updated with new developments **https://seedscience2021.com.au/**

Nature Conservation Council Bushfire Conference – 4-6 May 2021

The Nature Conservation Council of NSW's 12th Biennial Bushfire Conference will be held as a virtual event this year. The conference theme *Cool, Warm, Hot: the burning questions* will explore how different fire intensities can influence ecosystems and communities in a changing climate, with presentations by academics, agencies and practitioners. For the latest updates head to the website at **www.nature.org.au/Bushfire-Conference**

Research round up

COMPILED BY TOM LE BRETON
University of New South Wales

Albani Rocchetti, G., Armstrong, C.G., Abeli, T., Orsenigo, S., Jasper, C., Joly, S., Bruneau, A., Zytaruk, M. and Vamosi, J.C. (2020). **Reversing extinction trends: new uses of (old) herbarium specimens to accelerate conservation action on threatened species**. *New Phytologist*. https://doi.org/10.1111/nph.17133

Alfonzetti, M., Rivers, M.C., Auld, T.D., Le Breton, T., Cooney, T., Stuart, S., Zimmer, H., Makinson, R., Wilkins, K., Delgado, E. and Dimitrova, N. (2020). **Shortfalls in extinction risk assessments for plants**. *Australian Journal of Botany,* 68(6): 466-471. https://doi.org/10.1071/BT20106

Araia, M.G., Chirwa, P.W. and Syampungani, S. (2020). **Do strictly protected areas protect vulnerable local tree species better than human land use? Disentangling conservation value from biodiversity value.** *Journal for Nature Conservation,* 58: 125919. https://doi.org/10.1016/j.jnc.2020.125919

Bal, P., Rhodes, J.R., Carwardine, J., Legge, S., Tulloch, A., Game, E., Martin, T.G., Possingham, H.P. and McDonald-Madden, E. (2020). **How to choose a cost-effective indicator to trigger conservation decisions?**. *Methods in Ecology and Evolution,* 00: 1-10 https://doi.org/10.1111/2041-210X.13532

Bang, A. and Khadakkar, S. (2020). **Opinion: Biodiversity conservation during a global crisis: Consequences and the way forward**. *Proceedings of the National Academy of Sciences,* 117(48): 29995-29999. https://doi.org/10.1073/pnas.2021460117

Batavia, C., Nelson, M.P., Bruskotter, J.T., Jones, M.S., Yanco, E., Ramp, D., Bekoff, M. and Wallach, A.D. (2021). **Emotion as a source of moral understanding in conservation**. *Conservation Biology*. https://doi.org/10.1111/cobi.13689

Beveridge, F.C., Williams, A. and Adkins, S.W. (2020). **Seed enhancement technologies to improve germination and emergence of Australian native Poaceae**. *Seed Science Research*. https://doi.org/10.1017/S0960258520000276

Biedenweg, K., Trimbach, D., Delie, J. and Schwarz, B. (2020). **Using cognitive mapping to understand conservation planning**. *Conservation Biology,* 34(6): 1364-1372. https://doi.org/10.1111/cobi.13627

Burgess, T.I., López-Villamor, A., Paap, T., Williams, B., Belhaj, R., Crone, M., Dunstan, W., Howard, K. and Hardy, G.E.S.J. (2020). **Towards a best practice methodology for the detection of Phytophthora species in soils**. *Plant Pathology*, 00: 1-11. https://doi.org/10.1111/ppa.13312

Burton, J.E., Bennett, L.T., Kasel, S., Nitschke, C.R., Tanase, M.A., Fairman, T.A., Parker, L., Fedrigo, M. and Aponte, C. (2021). **Fire, drought and productivity as drivers of dead wood biomass in eucalypt forests of south-eastern Australia**. *Forest Ecology and Management,* 482: 118859. https://doi.org/10.1016/j.foreco.2020.118859

Charitonidou, M. and Halley, J.M. (2020). **What goes up must come down–why high fecundity orchids challenge conservation beliefs**. *Biological Conservation,* 252: 108835. https://doi.org/10.1016/j.biocon.2020.108835

Chokheli, V.A., Dmitriev, P.A., Rajput, V.D., Bakulin, S.D., Azarov, A.S., Varduni, T.V., Stepanenko, V.V., Tarigholizadeh, S., Singh, R.K., Verma, K.K. and Minkina, T.M. (2020). **Recent development in micropropagation techniques for rare plant species**. *Plants,* 9(12): 1733. https://doi.org/10.3390/plants9121733

Clarke, B., Thet, A.K., Sandhu, H. and Dittmann, S. (2021). **Integrating cultural ecosystem services valuation into coastal wetlands restoration: A case study from South Australia**. *Environmental Science and Policy,* 116: 220-229. https://doi.org/10.1016/j.envsci.2020.11.014

Coe, M.A. and Gaoue, O.G. (2020). **Cultural keystone species revisited: are we asking the right questions?.** *Journal of ethnobiology and ethnomedicine,* 16(1): 1-11. https://doi.org/10.1186/s13002-020-00422-z

Collette, J.C. and Ooi, M.K. (2020). **Distribution of seed dormancy classes across a fire-prone continent: effects of rainfall seasonality and temperature**. *Annals of Botany*. https://doi.org/10.1093/aob/mcaa203

Collette, J.C. and Ooi, M.K. (2020). **Investigation of 18 physiologically dormant Australian native species: germination response, environmental correlations and the implications for conservation**. *Seed Science Research* : 1-9. https://doi.org/10.1017/S0960258520000422

Crespin Guzmán, S., Moreira Arce, D. and Simonetti Zambelli, J. (2020). **Killing with compassion for the sake of conservation: response to Lynn *et al.* 2019**. *Conservation Biology,* 34(4): 1035-1037. https://doi.org/10.1111/cobi.13525

Delnevo, N., van Etten, E.J., Byrne, M., Petraglia, A., Carbognani, M. and Stock, W.D. (2020). **Habitat fragmentation restricts insect pollinators and pollen quality in a threatened Proteaceae species**. *Biological Conservation,* 252: 108824. https://doi.org/10.1016/j.biocon.2020.108824

Fernández-Pascual, E., Carta, A., Mondoni, A., Cavieres, L.A., Rosbakh, S., Venn, S., Satyanti, A., Guja, L., Briceño, V.F., Vandelook, F. and Mattana, E. (2020). **The seed germination spectrum of alpine plants: a global meta-analysis**. *New Phytologist.* https://doi.org/10.1111/nph.17086

Falster, D., Gallagher, R., Wenk, E., Wright, I., Indiarto, D., Baxter, C., Andrew, S.C., Lawson, J., Allen, S., Fuchs, A. and Adams, M.A. (2020). **AusTraits–a curated plant trait database for the Australian flora**. *bioRxiv.* https://doi.org/10.1101/2021.01.04.425314

Grice, A.C., Murphy, H.T., Clarkson, J.R., Friedel, M.H., Fletcher, C.S. and Westcott, D.A. (2020). A **review and refinement of the concept of containment for the management of invasive plants**. *Australian Journal of Botany,* 68: 602-616. https://doi.org/10.1071/BT20092

Gosper, C.R., Kinloch, J., Coates, D.J., Byrne, M., Pitt, G. and Yates, C.J. (2020). **Differential exposure and susceptibility to threats based on evolutionary history: how OCBIL theory informs flora conservation**. *Biological Journal of the Linnean Society.* https://doi.org/10.1093/biolinnean/blaa170

Gyeltshen, J., Dunstan, W.A., Shaw, C., Howard, K., Grigg, A.H., Hardy, G.E.S.J. and Burgess, T.I. (2021). **Metabarcoding shows multiple Phytophthora species associated with individual plant species: implications for restoration**. *European Journal of Plant Pathology,* 159: 359-369. https://doi.org/10.1007/s10658-020-02167-7

Heagney, E.C., Falster, D.S. and Kovač, M. (2021). **Land clearing in south-eastern Australia: Drivers, policy effects and implications for the future**. *Land Use Policy,* 102: 105243. https://doi.org/10.1016/j.landusepol.2020.105243

Hicks, B. and Elliott, T.F. (2020). **A simple method to collect viable rainforest tree seeds and study the frugivorous diet of satin bowerbirds *(Ptilonorhynchus violaceus).*** *Cunninghamia,* 20: 099–104 https://doi.org/10.7751/cunninghamia.2020.20.003

Hodgson, J.G., Montserrat Marti, G., Šerá, B., Jones, G., Bogaard, A., Charles, M., Font, X., Ater, M., Taleb, A., Santini, B.A. and Hmimsa, Y. (2020). **Seed size, number and strategies in annual plants: a comparative functional analysis and synthesis**. *Annals of Botany,* 126(7): 1109-1128. https://doi.org/10.1093/aob/mcaa151

Jellinek, S. and Bailey, T.G. (2020). *Establishing Victoria's Ecological Infrastructure: A Guide to Creating Climate Future Plots.* https://www.researchgate.net/publication/339252474

Juliana, D.F., Riccardo, B., Jörgen, W. and Erik, Ö. (2020). **Linear infrastructure habitats increase landscape-scale diversity of plants but not of flower-visiting insects**. *Scientific Reports,* 10: 21374. https://doi.org/10.1038/s41598-020-78090-y

Jung, V., Morel, L., Bonthoux, S. and Chollet, S. (2021). **Integrating species pools and abundance distribution in habitat conservation status assessment: A new index**. *Ecological Indicators,* 121: 107183. https://doi.org/10.1016/j.ecolind.2020.107183

Kelly, L.T., Giljohann, K.M., Duane, A., Aquilué, N., Archibald, S., Batllori, E., Bennett, A.F., Buckland, S.T., Canelles, Q., Clarke, M.F. and Fortin, M.J. (2020). **Fire and biodiversity in the Anthropocene**. *Science,* 370: 6519. https://doi.org/10.1126/science.abb0355

Lebbink, G., Dwyer, J.M. and Fensham, R.J. (2020). **An invasive grass species has both local and broad-scale impacts on diversity: Potential mechanisms and implications**. *Journal of Vegetation Science,* 32: e12972. https://doi.org/10.1111/jvs.12972

Lindenmayer, D. and Taylor, C. (2020). **Extensive recent wildfires demand more stringent protection of critical old growth forest**. *Pacific Conservation Biology,* 26(4): 384-394. https://doi.org/10.1071/PC20037

Lozada-Gobilard, S., Pánková, H., Zhu, J., Stojanova, B. and Münzbergová, Z. (2020). **Potential risk of interspecific hybridization in *ex situ* collections**. *Journal for Nature Conservation,* 58: 125912. https://doi.org/10.1016/j.jnc.2020.125912

Main, G., Middleton, C., Sear, M. and Stewart, L. (2020). **Documenting Australia's 2019/2020 bushfires**. *Museum Management and Curatorship,* 35(6): 697-704. https://doi.org/10.1080/09647775.2020.1842234

Martínez-Jauregui, M., Touza, J., White, P.C. and Soliño, M. (2020). **Choice of biodiversity indicators may affect societal support for conservation programs**. *Ecological Indicators,* 121: 107203. https://doi.org/10.1016/j.ecolind.2020.107203

Meyer, J.M., Leempoel, K., Losapio, G. and Hadly, E.A. (2020). **Molecular ecological network analyses: An effective conservation tool for the assessment of biodiversity, trophic interactions, and community structure**. *Frontiers in Ecology and Evolution,* 8: 588430. https://doi.org/10.3389/fevo.2020.588430

Mills, C.H., Waudby, H., Finlayson, G., Parker, D., Cameron, M. and Letnic, M. (2020). **Grazing by over-abundant native herbivores jeopardizes conservation goals in semi-arid reserves**. *Global Ecology and Conservation,* 24: e01384. https://doi.org/10.1016/j.gecco.2020.e01384

Morgan, J.W., McCarthy, M.A. and Willocks, E. (2020). **Does intraspecific variation in demography have implications for fire management of an obligate-seeder shrub across its geographic range?**. *Austral Ecology*. https://doi.org/10.1111/aec.12981

Muir, A., Heyes, S., Morgan, J., Hoebee, S., Enright, N., Whelan, R., Geschke, A., Bennett, A., Walsh, S., Weatherly, W. and Milne, R., **Conservation challenges for Victorian Banksias: Workshop May 2020**. *Ecological Management and Restoration* https://doi.org/10.1111/emr.12448

New, T.R., Sands, D.P. and Taylor, G.S. (2021). **Roles of roadside vegetation in insect conservation in Australia**. *Austral Entomology*. https://doi.org/10.1111/aen.12511

Paquin, L.J., Bourgeois, B., Pellerin, S., Alard, D. and Poulin, M. (2020). **Native plant turnover and limited exotic spread explain swamp biotic differentiation with urbanization**. *Applied Vegetation Science*, 00: 1-12. https://doi.org/10.1111/avsc.12550

Pegg, G.S., Entwistle, P., Giblin, F.R. and Carnegie, A.J. (2020). **Fire and rust–the impact of *Austropuccinia psidii* (myrtle rust) on regeneration of Myrtaceae in coastal heath following wildfire**. *Southern Forests: a Journal of Forest Science,* 82(3): 280-291. https://doi.org/10.2989/20702620.2020.1819154

Price, J.N., Schultz, N.L., Hodges, J.A., Cleland, M.A. and Morgan, J.W. (2020). **Land-use legacies limit the effectiveness of switches in disturbance type to restore endangered grasslands**. *Restoration Ecology*. https://doi.org/10.1111/rec.13271

Podhrázská, J., Kučera, J., Doubrava, D. and Doležal, P. (2021). **Functions of windbreaks in the landscape ecological network and methods of their evaluation**. *Forests* 12(1): 67. https://doi.org/10.3390/f12010067

Rayne, A., Byrnes, G., Collier-Robinson, L., Hollows, J., McIntosh, A., Ramsden, M., Rupene, M., Tamati-Elliffe, P., Thoms, C. and Steeves, T.E. (2020). **Reimagining conservation translocations through two-eyed seeing**. *People and Nature*, 2: 512-526. https://doi.org/10.1002/pan3.10126

Read, J.L., Firn, J., Grice, A.C., Murphy, R., Ryan-Colton, E. and Schlesinger, C.A. (2020). **Ranking buffel: Comparative risk and mitigation costs of key environmental and socio-cultural threats in central Australia**. *Ecology and Evolution,* 10(23): 12745-12763. https://doi.org/10.1002/ece3.6724

Saunders, M.E., Bower, D.S., Mika, S. and Hunter, J.T. (2020). **Condition thresholds in Australia's threatened ecological community listings hinder conservation of dynamic ecosystems**. *Pacific Conservation Biology*. https://doi.org/10.1071/PC20040

Sheringham, P., Richards, P., Gilmour, P., Smith, J. and Kemmerer, E. (2020). **A systematic flora survey, floristic classification and high-resolution vegetation map of Lord Howe Island**. *Cunninghamia*, 20: 035–09 https://doi.org/10.7751/cunninghamia.2020.20.002

Stanley, R. and Dymond, W., 2020. **Reducing risk to wild ecosystems in nursery production**. *Sibbaldia: the International Journal of Botanic Garden Horticulture.* https://doi.org/10.24823/Sibbaldia.2020.283

Stephenson, P.J. and Stengel, C. (2020). **An inventory of biodiversity data sources for conservation monitoring**. *PloS one* 15(12), p.e0242923. https://doi.org/10.1371/journal.pone.0242923

Sulis, E., Bacchetta, G., Cogoni, D. and Fenu, G. (2020). **From global to local scale: where is the best for conservation purpose?**. *Biodiversity and Conservation*, 30: 183-200. https://doi.org/10.1007/s10531-020-02085-4

Thomas, W.J., Anthony, J.M., Dobrowolski, M.P. and Krauss, S.L. (2021). **Optimising the conservation of genetic diversity of the last remaining population of a critically endangered shrub**. *AoB PLANTS*. https://doi.org/10.1093/aobpla/plab005

Traveset, A. and Richardson, D.M. eds. (2020). *Plant invasions: the role of biotic interactions* (Vol. 13). CABI.

van Dijk, K.J., Waycott, M., Quarmby, J., Bickerton, D., Thornhill, A.H., Cross, H. and Biffin, E. (2020). **Genomic screening reveals that the Endangered *Eucalyptus paludicola* (Myrtaceae) is a hybrid**. *Diversity,* 12(12): 468. https://doi.org/10.3390/d12120468

Wan, J.S., McDougall, K.L. and Liew, E.C. (2020). **The susceptibility of seven threatened species to *Phytophthora gregata* and the aetiology of the disease caused by it**. *Australian Journal of Botany*, 68(8): 595-601. https://doi.org/10.1071/BT20062

White, L., Catterall, C. and Taffs, K. (2021). **Fire can promote germination, recruitment and seed bank accumulation of the threatened annual grass *Arthraxon hispidus***. *Australian Journal of Botany,* 68(6): 413-424. https://doi.org/10.1071/BT20004

Wineland, S.M., Fovargue, R., Gill, K.C., Rezapour, S. and Neeson, T.M. (2020). **Conservation planning in an uncertain climate: Identifying projects that remain valuable and feasible across future scenarios**. *People and Natur,e* 00: 1-15. https://doi.org/10.1002/pan3.10169

Winoto-Lewin, Y. and Kirkpatrick, J.B. (2020). **Species of accidental woody epiphytes vary between host trees in Tasmanian wet forests**. *Australian Journal of Botany,* 68(8): 532-541. https://doi.org/10.1071/BT19104

Yare, B., Bell, S and Hunter, N. (2020). **Phenology of the threatened *Diuris praecox* (Orchidaceae), a range-restricted terrestrial orchid from central eastern New South Wales**. *Cunninghamia,* 20: 099-104. https://doi.org/10.7751/cunninghamia.2020.20.004

ANPC Corporate Members

ANPC gratefully acknowledges the support of the following corporate members:

Albury Botanic Gardens, NSW

Australian National Botanic Gardens, ACT

Ballarat Botanical Gardens, VIC

Botanic Gardens of Adelaide, SA

Centre for Australian National Biodiversity Research, ACT

Department of Biodiversity, Conservation and Attractions, WA

Environment, Planning and Sustainable Development Directorate, ACT

Naturelinks, VIC

Office of Environment and Heritage, Saving Our Species, NSW

Rockhampton Regional Council – Rockhampton Botanic Gardens

Royal Botanic Gardens and Domain Trust, NSW

Royal Botanic Gardens Victoria, VIC

Royal Tasmanian Botanical Gardens, TAS

Wingecarribee Shire Council

WSP Australia Pty Ltd

ORCHID CONSERVATION SYMPOSIUM

Image provided by Noushka Reiter and Ryan Phillips

22 & 23 JUNE 2021

Join us for free online talks on orchid ecology and threats.

Funded by: Australian Government

#orchidtalks

Thank you to our project partners:

Victoria State Government | Environment, Land, Water and Planning

NSW Government | Planning, Industry & Environment

NOSSA

Australian National Botanic Gardens

Botanic Gardens and State Herbarium

Royal Botanic Gardens Victoria

Parks Victoria

La Trobe University

Landscape South Australia Hills and Fleurieu

Australian Institute of Botanical Science

The Royal Botanic Gardens Sydney

Australian Network for Plant Conservation Inc

Australasian Native Orchid Society Victorian Group Inc

Learn more, subscribe to the mailing list and register at:

www.anpc.asn.au/projects/preventing-extinction-in-bushfire-affected-orchids/